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THE FERRY-BRIDGE AT BIZERTA.

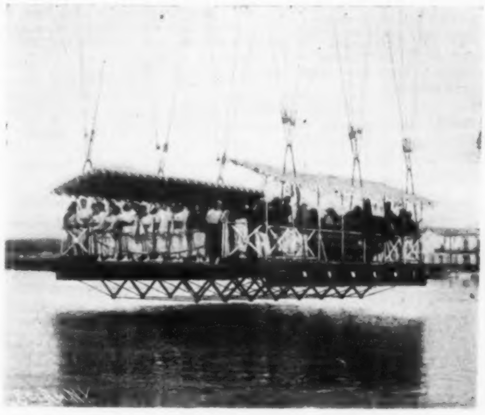
THE crossing of channels much frequented by shipping is a matter which has given no little concern to engineers. The solution of the problem is attended either with a temporary interruption of traffic or with no interruption at all. In other words, ferries or bridges must be employed. Floating ferries are the more defective, owing to their limited capacity, their liability to interruption by the action of tides, storms, fogs. They can be used only when the traffic along and across the waterway is small.

A system of bridge-ferriage has, however, been devised by F. Arnodin and De Palacio, which, in the last few years, has found increasing favor in the eyes of engineers. The system, it is claimed, leaves the channel entirely clear at all hours, requires no long and steep approaches, and transports persons and goods without change of level.

The Arnodin-Palacio ferry consists primarily of a straight, horizontal railway crossing the channel at a sufficient height to permit tall-masted vessels to pass at high tide. Evidently the type of structure most suitable for this railway is the suspension-bridge, because it is strong enough to sustain the load to be transported, because intermediate supports are unnecessary, and because but little resisting surface is offered to the wind. Messrs. Arnodin and Palacio therefore employ only stiffened suspension bridges of a special type with removable parts, supported on skeleton or built towers, with mooring cables anchored to shore and designed to take up the strains produced by the bridge on the towers. The platform of the bridge carries two lines of rails, on which a carrier travels by means of wheels varying in number with the weight to be carried. From the carrier a platform or car is suspended by means of wire stirrups, at the level of the quays on each side of the channel. The carrier comprises a frame suspended below the level of the rails and moves from one end to the other of the bridge. The car or ferry platform is decked, the suspending wires being arranged in triangles, so as to secure the necessary stiffness and to prevent oscillation. The carrier is driven by motive power of any kind. The carrier-wheels are arranged in pairs working on parallel rails placed closely together, forming each track, by which arrangement the carrier can not leave the track.

The ferry-platform or car can be designed to meet the most varied conditions of traffic. The bridge itself, constructed so as to comprise only those parts indispensable to strength, is provided with a framework of latticed girders well braced together. On each side of the platform thus formed are light footbridges for repairing and lubricating the moving parts.

The most recent application of the Arnodin-Palacio ferry-bridge system is to be found at Bizerta. The deep-water canal which connects the magnificent lake of Bizerta with the Mediterranean Sea cuts through the road which leads from Bizerta to Tunis. In order that traffic might not suffer from this destruction of the road, it was necessary to provide some means for bridging the canal. At first it was decided to employ row-boats; but the traffic was so great that a steam ferry-boat was constructed in 1892. Although the Mediterranean has no appreciable tides, there are, nevertheless, ebb and flood currents which vary with the condition of the sea. Against these currents the steam ferry proved ineffective when they were reinforced by the wind; for which reason the ferry-boat was guided to the slip on either shore by a heavy steel cable. This arrangement would no doubt have proved satisfactory enough under ordinary circumstances;



THE CAR.

but there was constant danger of the cable's blocking the passage of a ship. It was therefore decided to build a ferry-bridge after the system of Arnodin and Palacio.

The rails, in the Bizerta structure, are supported by the girders of a metallic platform. The cables whereby the platform is suspended are eight in number, anchored to the top of the towers. The strain on the towers is taken up by eight additional cables (four on each side of the channel), securely anchored in masonry on shore. Forty smaller cables extend from the towers and assist the main cables in supporting the rail platform. The distance between the towers is exactly equal to the width of the canal, namely, 109 meters (357·5 feet).

The platform is supported at a height of 45 meters (147·6 feet) above the quays. The car is 10 meters (32·8 feet) long and 7·5 meters (24·6 feet) wide. This car, together with the cables and carrier by which it is supported, weighs (unloaded) 24 tons and has a carrying capacity of over 56 tons. Sufficient room is to be found in the car for two large and four small carriages, together with 90 foot passengers, or for 270 passengers without any vehicles. The carrier is propelled by a steam engine placed above the great arch in the tower on the left bank. The steam engine drives a drum about which a steel cable is wound, passing over pulleys at each end of the railway and secured to the carrier. Although the engine is nominally of 15 horse power, a boiler of only 10 horse power is used, since the ferry is operated only intermittently. The car crosses the canal in about 45 seconds.

The ferry-bridge was begun in January, 1897, and opened for traffic on June 12, 1898. The total cost was 560,000 francs ($112,000).

THE LINK SUSPENSION BRIDGE AT BUDAPEST.

THE sixth bridge now being built over the Danube at Budapest is chiefly interesting for the application of links instead of wire ropes. Not to impede navigation on the river—which has near the Schwurplatz, under which name the bridge is known, a width of almost 1,000 feet—a suspension bridge with piers on the banks was decided upon. The final adoption of the link chain project of Czekelius, of the Hungarian Ministry for Commerce, came as a surprise. Link chains are more expensive than wire ropes, and in this instance the case was further complicated, because no Hungarian or foreign firm was in a position to supply links of the unusual dimensions required (up to 48 feet in length, 1 inch thick, weighing a ton each) in a hurry. But Hungary could certainly not have made wire ropes, and that may have outweighed other considerations. The bridge will, when completed in 1902, be Hungarian work in every respect. The raw material, Martin steel and Martin iron, comes from the government steel works at Diosgyör, a small place situated to the northeast of the capital. The iron structure is being erected by the Government Engineering Works at Budapest, whose manager, Seefehlner, has described the manufacture of the steel links and discussed the project; and the special machinery wanted for the making of the steel links has been constructed by the Vulcan Engineering Works at Budapest and Vienna. All of these machines are driven by triphase motors of Ganz & Company, of Budapest. Exceptional strength was demanded for the links, and the use of shears and punches forbidden. The work starts with rectangular steel bars. The bolt holes are bored in the rough, and the semicircular cheeks cut out of the heads at the same time. Then follow rounding off the heads and planing the middle straight parts, both sides at the same time, on a bed 50 feet long, all this for each single link. Then half a dozen or more links are united to a

THE FERRY-BRIDGE AT BIZERTA.

set, and the bolt holes are exactly bored through the whole set. Although the machines have given complete satisfaction, every link requires more than ten hours labor, and their number is 4,044. Yet the bridge is estimated not to cost more than £450,000, although the machinery will, in that shape, hardly be required again. As a curiosum we mention that the first suspension bridge built at Budapest, by T. W. and Adam Clark, during the years 1839 to 1849, cost $600,000 more than the present estimate.

THE PARIS EXHIBITION AWARDS.

NEARLY two months before the usual period of an exhibition's life, the participators in the World's Fair at Paris are able to advertise the fact that they have received a Grand Prix or a Gold Medal (probably several); or can find a poor consolation in the wholesale condemnation of their respective Commissions, their juries, the general organization; of anyone but themselves in short, if they are permitted only the cold shade of an honorable mention or bronze medal, or are passed over in disapproving silence; to say nothing of the gift of the silver diploma, that doubtful recognition which suspends the exhibitor midway, like Mahomet's coffin, between the upper plane of success and the lower level of failure. On the present occasion the limits are touched, on the one hand by one of our contemporaries, who congratulates a British exhibitor on his exceptional good fortune in obtaining the rare and priceless distinction of a Hors Concours; and on the other side, by the eloquent placard attached to his display by an indignant French exhibitor, "Evidently overlooked by the jury."

The system of granting awards to exhibitors is admittedly so incorrect, both in theory and practice, that the question whether such recognition should not be wholly abandoned is always earnestly considered in the preliminary work of every great exhibition; and it is always answered in the negative, chiefly because manufacturers attach so much importance to these too often fallacious tests of excellence, that they would to a large extent decline to assist at any exhibition where no awards were given. The reasons why the decisions of juries are, of a necessity, in many cases misleading and unjust, may be briefly stated. An enormous amount of work has to be done in a very short time, under the most difficult conditions of heat, and crowded buildings, and long distances; of superficial information, and more or less imperfect organization. Thus in Paris about 80,000 entries had to be considered by 121 juries, during the hottest season. It is inconceivable that justice can be done to all, and it is really wonderful that on the present occasion the jurors have performed their thankless task so well. Of course their work can be greatly facilitated or retarded by the exhibitors and their respective commissioners. An active exhibitor will take care to be on hand when his jury comes to examine his goods; he will supply full information; will explain details that are obscure on a superficial examination, and will make his status as a manufacturer thoroughly clear. An indifferent exhibitor may leave his fate in the hands of his agent (frequently to his own advantage), to his assistant, or wholly to chance. It should be added that, thanks to the jury, such an exhibitor often fares better than he deserves. On the other hand, it is one of the most important and necessary duties of a participating country's commissioners to watch with the most concentrated attention, and to act with untiring and tactful energy, in the interest of the exhibitors intrusted to their care throughout this critical period. Having their jurors well in hand, they must give them the fullest information as to their duties; must see that they attend meetings, or know the reasons of their absence; they must, as far as possible, have exhibitors at their posts to receive the juries; they must have an efficient staff watching and reporting the progress of the work; imperfect examinations or overlooked exhibits must be reported from day to day to the juries, and re-examinations insisted on. Mistakes or alleged injustice must not be lost sight of, but must be followed from day to day, from stage to stage, to the final court of appeal—the Jury Supérieur. As a matter of convenience and common courtesy, the juries should be provided with accommodation for meeting and discussion. It wants little consideration to see that satisfactory results depend largely on the manner in which the Commissioners and the exhibitors do their duty at this time. Neglect of it by either is worthy of all condemnation.

As for the juries, it is a general rule, which hardly admits of an exception, that they carry out their difficult task in a manner beyond praise. They are helped or retarded according to the efficient energy or the careless slackness of Commissioners and exhibitors; but whether they are helped as they should be, or impeded, as they certainly ought not to be, they continue their work from meeting to meeting to the end, often under the most fatiguing conditions, and are at least rewarded by the consciousness of a thankless task well performed.

As is usual, three classes of juries were organized to judge exhibits at Paris: the Class juries, whose function is to examine and report on entries; the Group juries, who supplement and carry forward the work of the Class juries; and the Superior jury, by whom alleged mistakes and injustices are considered and finally adjudged on. Obviously the burden of the work falls on the Class juries. Their composition is international, every country exhibiting, unless in an

TABLE I.—SHOWING THE NUMBER OF ENTRIES AT THE PARIS EXHIBITION. (COMPILED FROM OFFICIAL CATALOGUES.)

Nation.	I. Education.	II. Fine Arts.	III. Liberal Arts.	IV. Machinery.	V. Electricity.	VI. Civil Engineering and Transport.	VII. Agriculture.	VIII. Horticulture.	IX. Forestry and Sports.	X. Food Products.	XI. Mines and Metallurgy.	XII. Decoration and Furniture.	XIII. Textiles; Clothing.	XIV. Chemical Industry.	XV. Miscellaneous Industries.	XVI. Social Economy; Hygiene.	XVII. Colonisation.	XVIII. Army and Navy.	Totals.
1. France	5311	3236	1926	531	405	1537	1630	283	355	7551	607	1121	1490	850	1184	3011	488	330	31,946
2. French Colonies	126	203	138	18	8	128	1431	167	545	1394	148	228	346	259	218	38	255	8	5,658
3. Austria	14	314	107	25	25	48	0	1	8	16	23	127	107	44	76	43	42	9	1,035
4. Belgium	30	161	79	41	14	66	61	1	23	460	45	70	70	60	38	114	6	9	1,347
5. Britain	36	415	40	120	51	150	58	8	31	84	113	150	156	75	89	60	1	12	1,688
6. Bosnia	7	7	23	..	..	2	7	1	14	21	5	12	6	5	5	3	1	..	119
7. Bulgaria	11	45	33	..	..	13	102	3	5	109	11	44	60	75	32	2	..	..	605
8. Canada	11	18	9	7	2	31	56	254	32	110	56	32	39	25	19	..	..	..	701
9. Ceylon	..	..	..	..	..	..	..	45	64	22	34	11	7	6	61	..	11	..	261
10. China	3	..	11	1	..	7	11	2	16	9	7	25	20	7	18	2	..	4	137
11. Corea	1	..	6	1	..	4	5	4	6	3	3	8	8	5	6	1	..	1	62
12. Denmark	5	274	23	6	4	9	46	..	2	20	2	26	15	11	11	1	1	..	458
13. Ecuador	3	64	27	3	..	6	75	4	54	31	32	28	190	38	83	4	..	..	645
14. Germany	30	289	399	81	71	216	207	16	6	241	62	301	97	47	319	191	..	13	2,586
15. Greece	7	106	36	..	1	2	82	..	10	170	17	31	125	99	16	8	..	6	716
16. Guatemala	..	..	..	..	..	..	86	4	4	4	3	..	1	2	..	..	..	..	104
17. Holland	35	161	12	5	2	33	8	2	2	22	1	28	22	19	17	23	62	3	457
18. Hungary	405	309	117	33	27	149	503	57	239	434	154	165	186	81	146	172	..	37	3,304
19. India	1	..	..	..	..	1	4	..	7	5	15	23	18	5	35	..	4	2	125
20. Italy	152	331	215	28	27	70	296	60	50	408	76	286	361	159	227	429	..	7	3,188
21. Jamaica	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1
22. Japan	26	268	33	..	1	4	25	6	32	220	27	247	323	107	610	10	..	1	1,940
23. Liberia	..	..	..	..	..	..	9	..	3	2	..	..	..	..	..	..	..	..	14
24. Luxembourg	4	4	5	..	5	5	3	4	..	5	5	8	3	2	1	4	..	..	58
25. Mauritius	..	..	..	..	..	..	24	..	2	56	..	1	1	1	2	..	..	..	91
26. Mexico	168	151	342	14	25	105	550	48	191	430	428	98	459	256	77	46	1	30	3,419
27. Monaco	3	12	7	1	3	1	2	5	3	7	..	8	1	4	2	2	..	..	61
28. Nicaragua	1	1	6	..	..	..	87	..	7	9	3	..	5	3	..	..	..	..	122
29. Norway	28	136	44	11	10	12	9	..	27	20	24	36	3	27	33	..	..	2	423
30. Persia	..	..	5	..	..	..	1	..	..	..	..	9	2	..	8	..	..	..	25
31. Peru	1	27	20	..	1	15	42	3	27	63	60	11	38	34	12	6	1	3	364
32. Port d'Espagne	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1
33. Portugal	49	174	135	12	1	44	903	40	203	863	145	155	235	183	121	77	14	7	3,381
34. Roumania	43	106	65	6	5	38	454	5	18	228	67	69	133	74	38	25	..	15	1,406
35. Russia	312	432	124	26	17	124	269	75	101	347	122	114	263	114	115	362	1	85	3,013
36. Salvador	..	..	..	..	..	..	64	..	8	6	16	..	1	15	1	..	..	..	111
37. San Marino	..	9	8	..	..	1	7	1	1	8	1	7	7	1	2	2	..	..	55
38. Servia	10	56	13	1	1	8	75	25	8	76	7	38	58	7	11	4	..	1	402
39. Singapore	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	1
40. Spain	21	170	77	15	20	23	274	21	29	150	60	56	190	87	42	41	..	1	1,595
41. Sweden	23	172	22	35	14	6	14	..	9	21	45	27	7	49	39	24	..	1	508
42. Switzerland	12	237	80	14	25	45	28	1	..	102	11	43	52	4	115	30	..	1	833
43. Turkey	1	24	3	..	..	1	1	1	1	13	2	9	9	9	13	..	..	2	89
44. United States	252	505	550	282	283	456	1072	210	150	264	1297	262	113	92	106	615	..	37	6,674
45. West Australia	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..	2
Totals	7142	8620	4779	1317	1051	3378	8739	1361	2315	14,308	3735	3928	5256	2942	3948	5380	888	657	79,712

TABLE III.—DISTRIBUTION OF GRANDS PRIX AND GOLD MEDALS AMONG THE NON-COMMERCIAL GROUPS OF NINE NATIONS.

Nation	Group I. Education.			Group II. Fine Arts.			Group XVI. Social Economy.			Group XVIII. Colonisation.			Total Entries.	Total G. P.	Total G.	No. of Entries per G. P.	No. of Entries per G.
	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.					
France and colonies	5437	115	307	3539	51	135	3049	186	649	743	41	123	12,768	393	1214	32.5	10.5
Britain	36	18	44	415	6	20	60	19	27	1	3	1	512	46	92	11.1	5.5
Germany	30	..	7	289	9	24	191	34	64	..	..	..	510	43	95	11.8	5.4
United States	252	31	63	565	5	14	645	28	106	..	..	..	1,462	65	185	22.5	7.9
Belgium	30	6	5	161	5	12	114	31	96	6	1	4	311	43	117	7.2	2.6
Austria	14	3	15	314	2	12	43	9	14	42	1	10	413	15	51	27.5	8.1
Hungary	405	13	44	309	5	10	172	4	23	..	..	..	886	22	77	40.3	11.5
Switzerland	12	1	3	257	1	8	30	8	10	..	..	..	299	10	21	29.9	14.2
Russia	312	37	48	432	3	9	362	16	58	1	5	23	1,107	61	138	18.1	8
Totals	6528	225	536	6281	87	344	4666	335	1047	793	51	161	18,268	698	1930	26.2	9.2

TABLE II.—SHOWING NUMBER OF GRANDS PRIX AND GOLD MEDALS AS AWARDED TO EXHIBITORS AT THE PARIS EXHIBITION. (COMPILED FROM THE JOURNAL OFFICIEL.)

Makers.	I. Education.		II. Fine Arts.		III. Liberal Arts.		IV. Machinery.		V. Electricity.		VI. Civil Engineering and Transport.		VII. Agriculture.		VIII. Horticulture.		IX. Forestry and Sport.		X. Food Products.		XI. Mining and Metallurgy.		XII. Decoration and Furniture.		XIII. Textiles and Clothing.		XIV. Chemical Industries.		XV. Miscellaneous Industries.		XVI. Social Economy; Hygiene.		XVII. Colonisation.		XVIII. Army and Navy.		Total Awards.		Total Entries.	Entries per Award.	
	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	G. P.	G.	—	G. P.	G.
1. France; 2. French Colonies	115	307	51	136	98	462	30	134	49	126	100	481	68	478	12	31	45	116	78	964	58	279	67	286	160	1074	89	408	72	345	188	649	41	123	43	166	1379	6,566	37,604	27.3	5.7
3. Austria	3	15	2	12	12	40	5	4	5	17	9	29	8	27	1	..	7	15	3	13	3	12	6	31	10	44	10	16	2	10	9	14	1	10	2	2	98	311	1,035	10.5	3.3
4. Belgium	6	5	5	12	3	17	5	20	2	1	9	44	4	16	..	..	4	17	4	44	7	24	4	7	14	33	4	24	2	8	31	90	1	6	3	4	108	377	1,347	12.5	3.6
5. Britain	18	44	6	20	18	34	5	21	4	8	11	37	11	33	..	2	5	14	6	28	3	24	5	30	19	58	9	20	6	12	19	21	3	1	5	9	168	420	1,688	11.0	4
6. Bosnia	4	3	..	..	..	1	..	..	..	..	1	2	4	..	..	..	1	5	1	3	1	3	..	1	2	1	..	1	1	2	..	..	1	1	..	..	16	29	119	7.4	5.4
7. Bulgaria	..	3	..	..	..	2	..	..	..	..	..	4	2	10	..	..	1	..	1	11	..	1	..	2	..	..	..	5	..	..	..	1	..	..	..	..	4	48	605	151	12.6
8. Canada	4	3	..	..	1	2	..	..	..	..	..	2	9	8	1	3	4	..	1	1	7	14	..	..	..	..	..	3	..	2	..	3	..	..	..	..	27	42	701	25.8	16.7
9. Ceylon	..	..	..	..	..	1	..	..	..	..	..	..	..	1	..	..	1	2	1	1	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	3	12	261	87	21.7
10. China	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	2	..	3	..	..	..	1	..	..	..	..	..	1	..	8	137	..	17.1
11. Corea	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	1	2	62	62	31
12. Denmark	..	1	2	6	3	9	..	..	1	1	1	4	3	12	..	..	1	2	..	3	1	1	3	4	..	1	..	..	..	3	1	1	1	..	..	..	16	46	458	28.6	10.2
13. Ecuador	..	..	..	..	..	1	..	..	..	..	..	1	9	16	..	..	..	5	..	4	..	..	..	..	..	7	..	1	..	..	..	..	..	..	..	..	9	40	645	71.9	16.1
14. Germany	..	7	9	24	36	101	10	36	22	31	20	93	10	64	..	..	1	2	6	41	6	16	21	94	18	82	19	25	13	53	34	64	..	..	8	20	260	716	2,586	9.9	3.6
15. Greece	..	2	..	2	..	2	..	..	..	..	..	..	1	5	..	..	..	2	5	20	1	2	..	1	..	6	..	12	..	..	..	..	..	..	..	..	7	56	716	102.1	12.8
16. Guatemala	..	..	..	..	1	1	..	..	..	..	..	..	3	40	..	..	2	2	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	46	104	17.3	2.3
17. Holland	2	9	3	10	4	5	..	2	..	1	3	20	4	6	1	..	2	4	2	8	..	1	1	6	..	4	1	11	..	5	2	10	15	18	1	1	41	126	457	10.9	3.6
18. Hungary	13	44	5	10	4	16	1	6	4	11	5	13	18	56	2	14	16	27	8	30	5	22	3	31	2	11	3	15	..	10	4	23	..	..	1	6	88	339	3,304	37.5	9.7
19. India	17	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	5	1	3	1	1	1	1	..	..	..	..	..	1	..	..	..	..	..	..	23	11	125	5.5	11.3
20. Italy	..	30	4	30	7	30	1	3	2	7	3	20	14	41	..	6	1	4	6	54	6	15	3	31	20	62	6	24	1	12	31	81	..	..	3	2	108	494	3,188	29.5	6.5
21. Jamaica	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	1
22. Japan	5	7	..	4	2	5	..	..	..	..	..	1	3	11	..	..	3	16	1	15	1	4	3	22	11	19	5	12	6	26	..	2	..	..	2	2	42	148	1,940	46	13
23. Liberia	..	..	..	..	..	..	..	..	..	1	..	..	..	2	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	2	14	14	4.6
24. Luxembourg	1	1	..	..	..	1	..	..	..	..	..	1	2	..	..	1	..	..	1	2	..	1	..	..	..	2	1	3	..	..	1	2	..	..	..	..	6	14	58	9.7	4.1
25. Mauritius	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	91	..	45.5
26. Mexico	3	4	1	..	3	9	..	..	..	3	1	6	13	23	..	6	2	12	1	16	4	13	..	1	2	4	2	4	..	..	2	2	..	..	2	3	36	104	3,419	95	32.8
27. Monaco	..	..	..	1	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	3	..	..	..	..	..	..	1	..	..	..	..	..	1	6	61	61	10.1
28. Nicaragua	..	..	..	..	..	..	..	..	..	..	..	..	4	16	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	20	122	30.5	6.1
29. Norway	3	3	1	6	2	7	..	1	..	4	1	16	2	11	..	..	2	14	1	7	1	6	..	8	..	..	1	7	1	4	..	..	..	..	1	2	14	94	423	30.2	4.5
30. Persia	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	2	3	25	12.5	8.3
31. Peru	..	..	..	1	1	1	..	..	..	..	..	1	..	14	..	..	..	6	..	9	..	..	..	..	..	3	..	..	..	..	..	..	1	..	..	..	2	34	364	182	10.7
32. Porte d'Espagne	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
33. Portugal	4	10	1	2	7	10	..	1	..	..	1	5	7	42	..	3	5	10	9	41	2	10	..	1	1	11	..	5	..	..	..	3	1	..	2	2	40	171	3,381	84.5	19.7
34. Roumania	5	9	..	..	2	6	..	..	..	4	1	4	3	22	..	4	4	5	4	61	4	6	..	7	1	1	6	6	..	1	4	7	..	..	2	8	43	211	1,406	32.7	6.7
35. Russia	37	48	3	9	14	48	1	7	4	1	14	26	21	96	3	20	12	17	16	51	16	34	5	25	35	70	18	19	3	15	26	56	5	22	15	29	236	600	3,013	12.8	5
36. Salvador	..	..	..	..	..	..	..	..	..	..	..	..	4	12	..	..	..	2	..	1	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	18	111	27.7	6.2
37. San Marino	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	3	55	..	18
38. Servia	..	1	..	2	..	3	..	..	..	..	..	..	4	17	..	..	..	1	1	1	1	1	..	1	..	..	1	..	..	..	..	1	..	..	..	..	7	36	402	57.4	11.1
39. Singapore	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
40. Spain	..	1	4	5	..	9	..	..	..	1	..	2	5	38	..	..	1	..	6	35	2	8	..	5	4	21	1	5	2	4	..	1	..	..	..	..	25	133	1,596	63.8	12
41. Sweden	6	5	2	4	2	3	2	7	1	2	..	1	1	1	..	..	2	4	..	1	5	17	1	16	..	7	3	7	..	7	2	5	..	..	..	1	28	96	508	18.2	5.3
42. Switzerland	1	3	1	8	8	17	9	15	5	8	3	8	1	1	1	..	..	..	5	14	..	..	..	9	14	30	1	1	10	23	8	10	..	..	..	1	67	164	832	12.4	5.1
43. Turkey	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	2	..	..	..	1	2	..	..	..	..	..	..	2	..	5	7	89	17.8	12.7
44. United States	36	66	5	14	17	41	10	36	6	33	16	65	22	66	1	4	4	29	6	61	15	42	5	27	11	72	7	26	8	26	28	100	..	1	4	11	200	642	6,674	33.3	10.4
45. West Australia	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	4	..	2	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	4	2	.67	..
	279	688	106	309	244	578	79	281	56	249	218	829	276	1274	23	99	165	344	174	1548	178	558	150	634	331	1565	179	683	127	570	381	1176	71	178	96	287	3113	12,169	79,712	25.6	6.5

insignificant manner, being represented by one or more members in each class. The president is, as a rule, of the nationality of the country holding the exhibition; the vice-president is usually a foreigner; at least half the members are native, the remainder being of different nationalities. The common method of arriving at the value of an exhibit is by judging on various points, and allowing certain numbers to each point. Thus the points may be: Utility; Novelty; Workmanship; Standing of the exhibitor; General effect of exhibit. To each of these points, numbers are assigned, according to the opinion of each juror, who fills up forms with the respective number he decides on. Thus, from 1 to 5 may represent an Honorable Mention; 6 to 10 a Bronze Medal; 11 to 15 a Silver Medal; 15 to 20 a Gold Medal; and 20 to 25 a Grand Prix. An average of these values on each point of merit records the opinion of each juror; a general average of all the jury papers thus filled expresses the opinion of the jury, which may be traversed by the president, and votes taken on points raised. A unanimous zero casts the exhibitor into outer darkness. It is obviously thus within the power of the national members of each jury to favor their own exhibitors and to depreciate foreign competitors. We wish to emphasize this fact strongly, as well as the composition of the juries, which contained in every case a large majority of Frenchmen. Now, if we look at the results obtained, we see one fact standing out most prominently, namely, that the juries have given to British exhibitors far more than they deserve. It is a remarkable and satisfactory thing that the spirit of generosity has—as shown by results—animated some 1500 French jurors and led them to assess our participation far above its value. The lesson will not be lost on some, though doubtless many a British exhibitor may ascribe to his own superior merit what he owes to French consideration strained considerably.

We publish on the opposite page two tables. The first is an analysis of the participation in the Exhibition; the second is an analysis of the awards. Table I. was compiled from the French official catalogue, a work in 18 volumes; the numbers set against each group represent the number of entries in that group, not of actual exhibitors. The former, of course, greatly exceeds the latter (except in Group II.), because exhibitors, to increase their chances of awards, make cross-entries in separate but allied classes, so that one exhibitor may appear in half a dozen classes of the same group, besides being in separate groups; in the latter case, however, he becomes a bona fide, distinct exhibitor.

Table No. II. has been compiled from the list published in the Journal Officiel. Only Grands Prix and Gold Medals are dealt with, because the lower diplomas are but doubtful compliments. The special supplement of the Journal Officiel devoted to the lists contains 320 pages, each with three columns of closely printed type, in which the grades of the awards are separated; but the nationalities are confusedly mingled. The work of setting up and promptly publishing this record of some 45,000 awards was a very heavy one, and doubtless not a few errors exist; while it is more than probable that some sins of omission and commission have been made in the work of analyzing the closely-printed pages, and concentrating them in the form of a table. We explain this because we wish these results not to be regarded as absolutely, but only as approximately, correct, although so nearly accurate that the results recorded will not be materially affected. Two or three omissions also occur in the tables, and the deficiency may be supplied here. Thus the little Republic of Andorra is represented by one or two entries; Siam made a few exhibits, and has received due recognition; the Orange River State made at least one contribution, and the then Government of the Transvaal built and filled a pavilion, and was accorded various Grands Prix of the official nature. Of two other Tables, III. and IV., we may say here that the former refers to awards made in non-commercial groups, and the other to entries and awards in seven groups of the highest importance to us industrially, our own participation being placed in comparison with seven other important nations. It may be pointed out that in Group XVII., Colonization, Britain is conspicuous by abstention, as shown in Table III. There would have been an entire absence of this country in colonization exhibits, had not Messrs. Huntley & Palmer saved the situation with a tin of colonial biscuits, and another exhibitor by a contribution of equal national importance. The one was rewarded with a Grand Prix, the other by a Gold Medal. It is clear this section cannot be regarded strictly as a non-commercial one; it contains, however, so many important exhibits of an official or semi-official character that it is better so to regard it.

We may take a few of the results shown by the tables. Referring to No. 1, it will be seen that the total number of entries, which are probably not quite exact, on account of modifications made since the catalogue was compiled, but which nevertheless are the only official figures, show a total number of entries of nearly 80,000, of which more than half are contributed by France and her Colonies. In point of numbers, the leading foreign countries take the following order:

United States	6674
Hungary	3304
Russia	3013
Germany	2586
Britain	1702
Belgium	1347
Austria	1035
Switzerland	882

It will be seen that we stand fifth on the list, while in the groups in which we are more especially interested (see Table IV.) we take a sixth place, the order being:

United States	3403
Hungary	1508
Russia	1158
Germany	806
Belgium	751
Britain	657
Austria	246
Switzerland	239

TABLE IV.—PARIS EXHIBITION AWARDS (GRANDS PRIX AND GOLD MEDALS) TO EIGHT CHIEF NATIONS EXHIBITS IN GROUPS IV., V., VII., X., XI., XIII., AND XV. (COMPILED FROM THE JOURNAL OFFICIEL.)

NATIONS.	IV. Machinery.			V. Electricity.			VII. Agriculture.			X. Food Products.			XI. Mining and Metallurgy.			XIII. Textiles and Clothing.			XV. Chemical Industries.			Totals.	Totals.	Totals.	Entries per		Total G. P. and G. M.	Entries per G. P. and G. M.
	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.	Entries.	G. P.	G.	G. P.	G.		
Britain	120	5	21	51	4	8	58	11	35	84	6	29	113	3	24	156	19	53	75	9	20	657	57	190	11.5	3.4	247	2.66
Germany	81	10	35	71	22	31	207	19	61	241	6	41	62	6	16	97	18	52	47	19	25	806	100	261	8	3.1	361	2.23
United States	282	10	26	283	6	23	1072	22	64	264	6	49	1297	18	42	113	11	25	92	7	26	3403	80	255	42.6	13.3	335	10.16
Belgium	41	5	20	14	2	1	61	4	10	460	4	44	45	7	24	70	14	33	60	4	24	751	40	156	18.7	4.[illegible]	196	3.83
Austria	25	5	4	25	5	17	6	8	27	16	3	13	23	3	12	107	10	44	44	10	16	246	41	133	5.6	1.[illegible]	177	1.39
Hungary	33	1	6	27	4	11	593	18	56	434	8	30	154	5	22	186	2	11	81	3	15	1508	41	151	36.8	10.0	192	7.85
Switzerland	14	9	15	28	5	8	28	1	5	102	5	14	11	..	..	52	14	33	4	1	1	239	35	76	6.8	3.1	111	2.15
Russia	26	1	7	17	4	1	260	21	99	347	16	51	122	16	34	263	33	76	114	18	19	1158	109	287	10.6	4	396	2.93
Totals	622	46	134	516	52	100	2294	104	357	1948	54	271	1827	58	174	1044	121	327	517	71	146	8768	506	1509	17.3	5.8	2015	4.35

TABLE V.—*Number of Entries per Grand Prix and Gold Medal taken together, Awarded to Eight Chief Nations, Exhibiting in Group IV.*

Machinery.

Nation.	No. of Entries.	No. of G. P.	No. of G.	Total G. P. and G.	No. of Entries for each G. P. and G. Awarded.
1. Switzerland	14	9	15	24	.58
2. Belgium	41	5	20	25	1.6
3. Germany	81	10	35	45	1.8
4. Austria	25	5	4	9	2.8
5. Russia	26	1	7	8	3.2
6. Hungary	33	1	6	7	4.7
7. Britain	120	5	21	26	4 6
8. United States	282	10	28	36	7.8

TABLE VI.—*Number of Entries per Grand Prix and Gold Medal taken together, Awarded to Eight Chief Nations Exhibiting in Group V.*

Electricity.

Nation.	No. of Entries.	No. of G. P.	No. of G. M.	Total G. P. and G. M.	No. of Entries for each G. P. and G. M.
1. Austria	25	5	17	22	1.1
2. Germany	71	22	31	53	1.3
3. Hungary	27	4	11	15	1.8
4. Switzerland	28	5	8	13	2 1
5. Russia	17	4	1	5	3.4
6. Britain	51	4	8	12	4.2
7. Belgium	14	2	1	3	4.6
8. United States	283	6	23	29	9.8

TABLE VII.—*Number of Entries per Grand Prix and Gold Medal taken together, Awarded to Eight Nations Exhibiting in Group VII.*

Agriculture.

Nation.	No. of Entries.	No. of G. P.	No. of G. M.	Total G. P. and G. M.	No. of Entries per G. P. and G. M.
1. Austria	6	8	27	35	.17
2. Britain	58	11	35	46	1.26
3. Russia	269	21	99	120	2.2
4. Germany	207	19	61	80	2.6
5. Belgium	61	4	10	14	4.4
6. Switzerland	28	1	5	6	4.7
7. Hungary	593	18	56	74	8.0
8. United States	1072	22	64	86	12.4

TABLE VIII.—*Number of Entries per Grand Prix and Gold Medal taken together, Awarded to Eight Nations Exhibiting in Group X.*

Food Products.

Nation.	No. of Entries.	No. of G. P.	No. of G. M.	Total G. P. and G. M.	No. of Entries per G. P. and G. M.
1. Austria	16	3	13	16	1
2. Britain	84	6	29	35	2.4
3. United States	264	6	49	55	4.8
4. Germany	241	6	41	47	5.1
5. Russia	347	16	51	67	5 2
6. Switzerland	102	5	14	19	5.4
7. Belgium	460	4	44	48	9.6
8. Hungary	434	8	30	38	11.4

TABLE IX.—*Number of Entries per Grand Prix and Gold Medal taken together, Awarded to Seven Nations Exhibiting in Group XI.*

Mining and Metallurgy.

Nation.	No. of Entries.	No. of G. P.	No. of G. M.	Total G. P and G. M.	No. of Entries per G. P. and G. M.
1. Austria	23	3	12	15	1.5
2. Belgium	45	7	24	31	1 4
3. Russia	122	16	34	50	2.4
4. Germany	62	6	16	22	2.8
5. Britain	113	3	24	27	4.2
6. Hungary	154	5	22	27	5.7
7. United States	1297	18	42	60	21.6

TABLE X.—*Number of Entries per Grand Prix and Gold Medal taken together, Awarded to Eight Nations Exhibiting in Group XIII.*

Textiles and Clothing.

Nation.	No. of Entries.	No. of G. P.	No. of G. M.	Total G. P. and G. M.	No. of Entries per G. P. and G. M.
1. Switzerland	52	14	33	47	1.1
2. Germany	97	18	52	70	1.4
3. Belgium	70	14	33	47	1.5
4. Austria	107	10	44	54	1.9
5. Britain	156	19	53	72	2.1
6. Russia	263	33	76	109	2.4
7. United States	113	11	25	36	3.1
8. Hungary	186	2	11	13	14.3

TABLE XI.—*Number of Entries per Grand Prix and Gold Medal taken together, Awarded to Eight Nations Exhibiting in Group XV.*

Chemical Industries.

Nation.	No. of Entries.	No. of G. P.	No. of G. M.	Total G. P. and G. M.	No. of Entries per G. P. and G. M.
1. Germany	47	19	25	44	1.07
2. Austria	44	10	16	26	1 7
3. Switzerland	4	1	1	2	2.0
4. Belgium	60	4	24	28	2.1
5. Britain	75	9	20	29	2.6
6. United States	92	7	26	33	2.8
7. Russia	114	18	19	37	3.1
8. Hungary	81	3	15	18	4.5

It will be noticed that Austria stands very low upon the list, the reason being that in many cases her exhibits were collective, and therefore not capable of being stretched over many entries. Thus in Group VII., her six exhibits were made by about 400 exhibitors. On the other hand, Britain having but few collectivities appears in much more apparent than actual force. Judged by the test of number of entries, the only test that can be applied just now for comparison, though obviously it is not final, we see the positions assigned by the juries in the seven important groups (see Tables V. to XI.) In Group IV., Machinery and Mechanical Engineering, Switzerland takes the first, and Britain the seventh place. In Group V., Electricity, Austria stands first, and Britain sixth. Here the result of a small number of entries of high values is illustrated, for Austria owes her premier position to it. Germany, however, being very nearly as good, with almost three times the number of exhibitors. Great Britain, with 51 exhibitors only, as compared to Germany's 71, stands in the proportion of 4·2 to 1·3 of entries per Grand Prix and Gold Medal, showing that multiplicity of entries do not necessarily carry numerous awards. The results in Table VII. (for Group VII., Agriculture) further illustrate this; here Britain, with a few exhibitors, takes a second place, chiefly on account of the admirable efforts made by a few of our agricultural engineering exhibitors. The same position is occupied by Britain in Group X. (Food Products), where a repetition of awards to some of the more pushing exhibitors has raised the standard of excellence to a somewhat false level. In Mining and Metallurgy, Group XI. and Table IX., we have more than we merit, and thereby are only fifth on the list. The same rank is gained by us in Group XIII., Textiles, and Clothing (Group X.), Switzerland, Germany, Belgium, and Austria being all ahead of us so far as the award test is applicable. Finally, in Group XV., Chemical Industries (Table XI.), we have the same relative position. It is somewhat remarkable that the United States should not have taken a higher place than she has done in any of these comparisons. Probably this may be partly accounted for by several reasons; her exhibitors have not the same record of awards behind them; and exhibits of the highest class have been mixed up with others of a much inferior order, so that the whole display has been largely watered. Especially is this the case with Groups X. and XI., which are in all respects better than those of Britain.

We must repeat that we have not instituted these comparisons with any intention that they should afford a measure of actual relative merits, but they are the only indications that officially exist. We insist, however, that the results show a unanimous measure of good will on the part of the jurors, who might, in all justice, have placed us in a far inferior position. The temptation to do so must have been considerable among the French judges. As a nation we displayed a stupid want of sympathy with the Exhibition; those of our manufacturers who came in, have done so, with but few exceptions, in the haphazard, slovenly manner which has been in deplorable contrast with the honor done by all other nations to the great commercial festival with which France has closed the century. We have stamped our insular peculiarities on our somewhat gloomy pavilion in the Rue des Nations; we have, in short, done something to discourage, and but little to encourage, the éclat of the Paris Exposition.

Yet in spite of all these things we have been placed high up in the scale of merit among the nations. The result ought, at least, to dispel many misunderstandings; but probably it will have the effect of strengthening the belief of the British manufacturer in his old bad and obsolete system of exhibiting, and of confirming his conviction in British superiority. A detailed examination of the British awards will be considered shortly.—Engineering.

FRENCH RAILWAYS AND THEIR WORK.

By Charles Rous-Marten.

LE CHEMIN DE FER DE PARIS-ORLEANS.

Upon the accession of M. Solacroup, the present very able Ingénieur en Chef du Matériel et de la Traction, to the chief command in the department of mechanical engineering on the Orleans line, it was decided to adopt the type of four-cylinder compound engines which had proved so markedly successful on the Nord, Midi, and P. L. M. railways, and which had been more recently adopted on the Est, Ouest, and Etat lines. That is to say, the new engines which M. Solacroup designed for the express service were to have the De Glehn system of compounding, but were modified in respect of various details as compared with the locomotives built on the same principle for other French railways.

In external appearance the Orleans closely resemble those previously in use on the Nord and Midi lines. Most of the striking features which characterized previous Orleans engines have been abandoned, including the two huge domes connected by a large steam pipe passing through a high cylindrical sandbox, and also the casing of these as well as of the boiler with burnished sheet brass. But certain peculiarities of the Polonceau engines have been retained, perhaps the most important being the Tenbrinke heater in the firebox. The Walschaert valve gear is used, as in the case of all compounds of the same type. Twenty-five engines of this class have been ordered for the Orleans line, and twenty are already at work. They are numbered 1 to 25, and are painted black with narrow red lines.

Comparing the new Orleans engines with the Nord compounds which I have previously described, I may say that they have slightly larger cylinders and slightly smaller driving wheels. Translating French dimensions into their nearest English equivalents, the Orleans engines have high pressure cylinders 13¾ inches in diameter, and low pressure 21½ inches, as against 13½ inches and 20¾ inches in the Nord engines; while the coupled wheels are 6 feet 10 inches in the Orleans locomotive, instead of 6 feet 11¼ inches, as in the case of those on the Nord line. The heating surface is practically the same as in the Nord engines numbered 2·158 to 2·160, viz., 1,890 square feet, but the fire grate area is a little smaller, viz., 26½ square feet instead of 28. The steam pressure is the same in each case, namely, 213 pounds to the square foot. But the weight of the new Orleans engines is considerably greater than that of any of the Nord engines, excepting, of course, the latest design, the ten-wheeled, or Atlantic type, being 54¼ tons in working order. The tender is small, weighing only 37 tons loaded.

The principal dimensions of the engine under notice are as follows:

Cylinders, high pressure, two, diameter	13¾ inches.
Cylinders, low pressure, two, diameter	21½ inches.
Piston stroke	25¼ inches.
Coupled wheels, four, diameter	6 feet 10 inches.
Boiler, internal diameter	4 feet 6¼ inches.
Boiler, length between tube plates	12 feet 9½ inches.
Boiler, height of center above rails	8 feet ⅛ inch.
Tubes, number	111
Tubes, external diameter	2¾ inches.
Heating surface, tubes	1,730 square feet.
Heating surface, firebox	160 square feet.
Heating surface, total	1,890 square feet.
Grate area	26½ square feet.
Steam pressure per square inch	213 pounds.
Valve gear—Walschaert.	
Weight in working order	54¼ tons.
Adhesion weight	33 tons.

Such are the general features of the new engines which now perform the principal express driving on the Orleans Railway. That line has the distinction, in connection with the Midi Railway, of running the fastest long-distance train in the world, the distance of 486¼ miles from Paris to Bayonne being booked to be covered in 8 hours 59 minutes, or at the average rate of 54·2 miles an hour. The Orleans share of this splendid performance consists in running the distance of 363½ miles from Paris to Bordeaux, St. Jean Station, in 6 hours 42 minutes, the average speed being the same as that for the entire journey onward to Bayonne. Great Britain has nothing to show that at all approaches this achievement over so long a distance, and as I have demonstrated in previous articles, the French road is by no means free from gradients, such banks as 1 in 125 for five miles together, and 1 in 170 to 1 in 200 for long distances, having to be ascended.

But the most important work allotted to the new compounds consists in running the heavy day express, which often exceeds 200 tons behind the tender, and is booked to run from Paris to Bordeaux in 7 hours 5 minutes; also from Bordeaux to Paris in 6 hours 59 minutes. I have already given some illustrations of the remarkable efficiency with which the engines perform this duty with very considerable loads.

The maximum speed on the Orleans line is limited by State decree to 120 kilometers — 74·5 miles an hour. This is a material expansion of the limit which existed two years ago, viz., 112½ kilometers = 70 miles per hour. The engines run with perfect ease at the higher rate, taking large loads; indeed, their speed capacity is in reality far higher, for I have found them able in trials to attain speeds of 80 to 85 miles an hour. But such velocities are not sanctioned in ordinary practice.

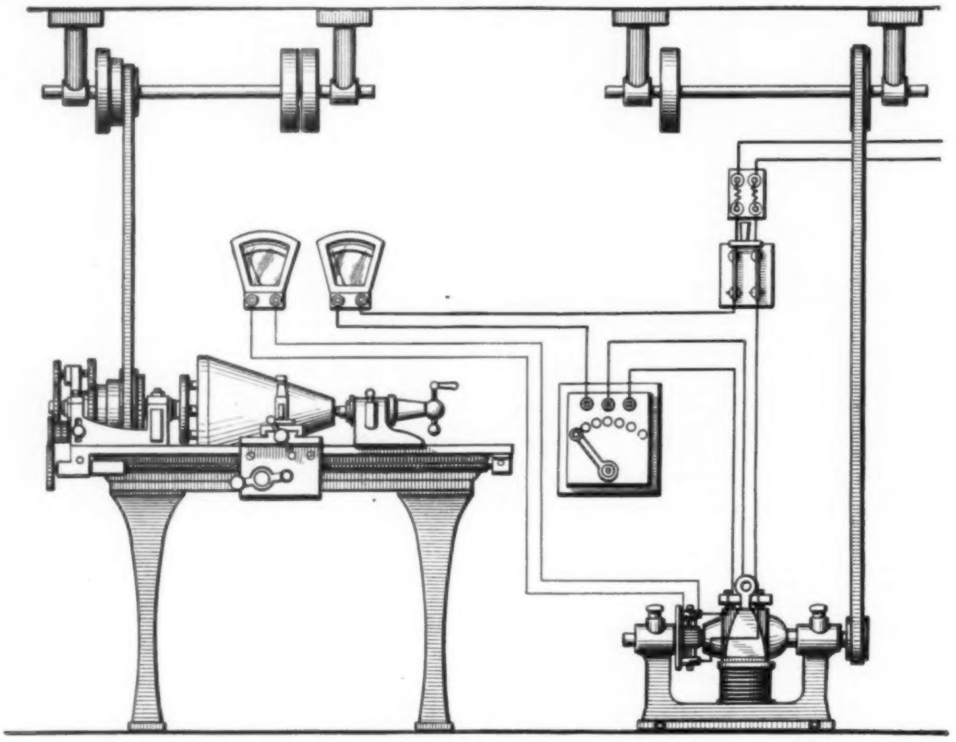
An illustration of the new engine appears below. We are indebted to The Engineer, of London, for the engraving and description.

THE POWER REQUIRED TO DRIVE SMALL LATHES.

By Nevil Monroe Hopkins, M.S., Washington, D. C.

Having been consulted several times regarding the energy absorbed at the cutting tools of small engine lathes, and the necessary amount of power required to drive them under various conditions, the writer undertook a few measurements for the purpose of rendering reliable opinions. The advice of a number of practical men had previously been obtained, which resulted in the collection of figures varying greatly in value, and rendering it impossible to predetermine the size of engine or motor to purchase for driving a given lathe. It was apparent to the writer that the energy required could be determined to almost any degree of nicety by refined electrical measurements. The accompanying drawing illustrates the plan put into operation at the research laboratory of the present experimenter, and may be reproduced by any one having the means at hand for measuring electrically the energy absorbed by almost any class of machine tool, as well as the lines of shafting, belting, etc.

The lathe shown was a 12 inch swing, back-geared screw-cutting tool of ordinary pattern and was belted to the usual short countershaft. The electric motor employed as the source of power was belted to its own separate countershaft, and the two short pieces of shafting were belted over to the main line of shafting, not shown in the illustration. The measuring instruments consisted of the most delicate laboratory standards and indicated faithfully minute variations in load. The ammeter, as will be noted, is in direct circuit with the main supply to the motor, and the voltmeter is connected across the brushes. It is evident that the electrical power absorbed by the motor, its countershaft, the main countershaft, belting, electrical conductors, etc., may be read from the instruments with precision, and recorded, to be deducted from the subsequent readings when only the power absorbed by the lathe is wanted.

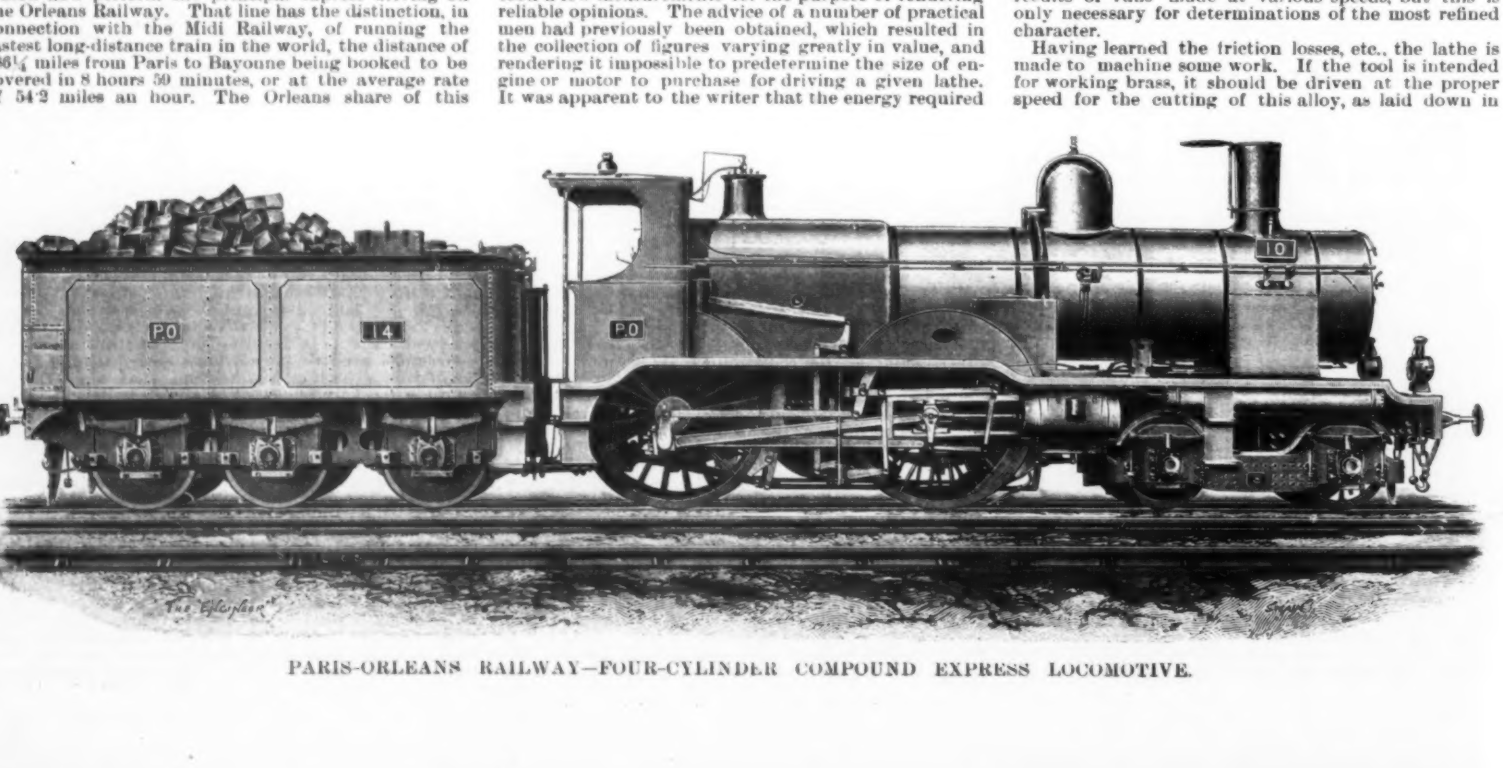


MEASURING THE POWER REQUIRED TO DRIVE A SMALL LATHE.

With the present scheme of connections, it is only necessary to multiply the reading of the voltmeter by the reading of the ammeter and divide the product by 746, to ascertain the horse power absorbed during any period of the run. The readings of voltmeter and ammeter respectively should be made by separate persons and recorded independently, where the greatest accuracy is sought, as it is rather difficult for the same person to make the two readings simultaneously.

Having determined the power absorbed at all shafting and belting, the lathe is thrown in, and a second reading taken with the tool running idle. Subtracting one set of figures from the other gives the power required to overcome the friction of the bearings of the lathe at the speed at which the machine is being driven. The friction losses ascertained by the writer were the results of runs made at various speeds, but this is only necessary for determinations of the most refined character.

Having learned the friction losses, etc., the lathe is made to machine some work. If the tool is intended for working brass, it should be driven at the proper speed for the cutting of this alloy, as laid down in



PARIS-ORLEANS RAILWAY—FOUR-CYLINDER COMPOUND EXPRESS LOCOMOTIVE.

works devoted to machine shop practice, or if iron or steel is to be worked, the corresponding prescribed speeds are of course observed.

In all this work it should be remembered that for double-cutting, boring tools, etc., the power required will be greater than for simple cutting-off tools and the like.

The lathe as illustrated is provided with an iron cone, designed to be turned down, and it was by taking cuts of equal depths, at different radii, that the writer obtained the figures which are herein given for lathes of different sizes.

It is of course assumed that the friction of oiled bearings, which is exceedingly small, is the same in lathes of all sizes from the one and one-half inch swing to those of six-inch swing, or in other words, with lathes having three-inch face plates up to lathes with twelve-inch face plates. It is with this assumption evident that the figures given for the smaller lathes are a trifle too high, because what the writer terms the "oiled friction" in the smaller lathes is probably less than the oiled friction of the larger tools. The oiled friction for the present spindle and gear was too small to warrant recording, thus making the percentage of error in the figures for the small lathes insignificant.

Having described the system of measurement upon which this article is based, the respective powers, expressed in terms of horse power, are given for small lathes of various sizes.

In making the following table, a ten per cent. factor of safety was allowed upon the actual figures obtained. The various sizes of small engines and motors were then looked over, and the rated "horse power size" chosen for the special purposes, which left us intact the ten per cent. factor of safety, and where this margin was encroached upon, the motor of the next larger size was chosen. It will thus be seen that the following figures are generous, and may be adopted with safety.

3	inch face plate,	or lathes	with	1½	inch swing	¼	horse power.
4	"	"	"	2	"	¼	"
5	"	"	"	2½	"	⅓	"
6	"	"	"	3	"	⅓	"
7	"	"	"	3½	"	½	"
8	"	"	"	4	"	½	"
9	"	"	"	4½	"	⅔	"
10	"	"	"	5	"	⅔	"
11	"	"	"	5½	"	¾	"
12	"	"	"	6	"	¾	"

If only a single lathe and a simple line of shafting is to be considered, the powers as recommended will prove ample.

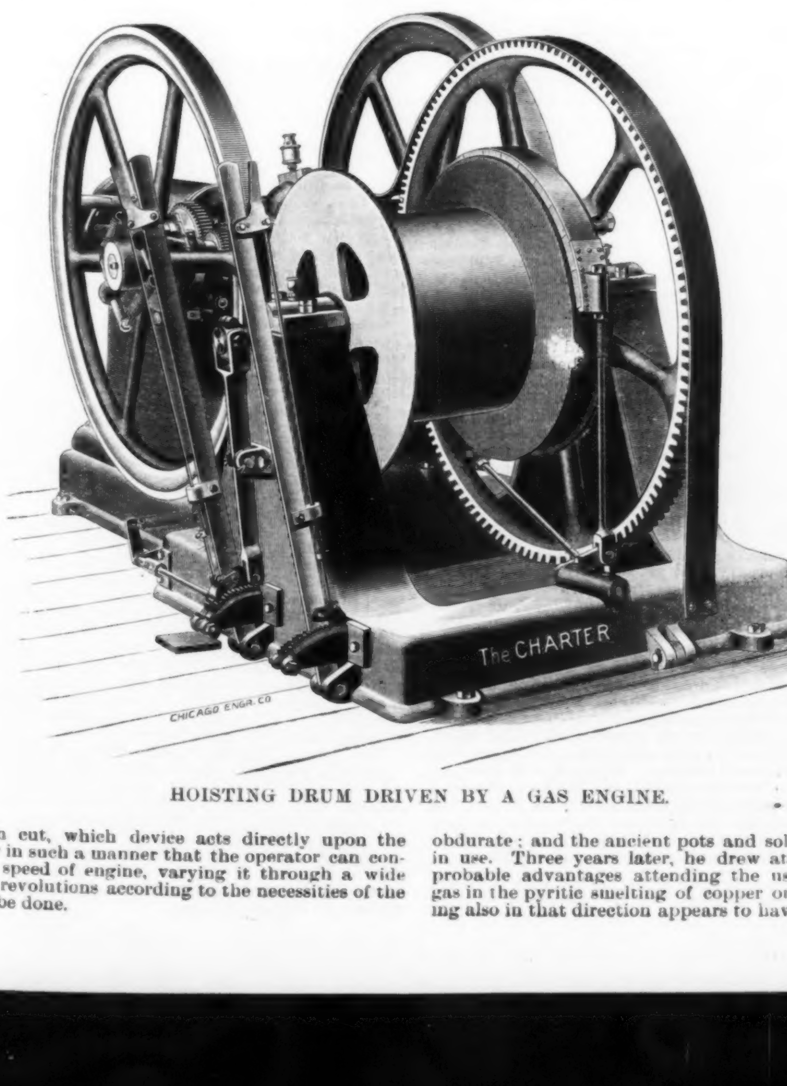
A NEW USE OF GAS ENGINES.

A HOISTING drum directly driven by a gas engine and designed for mining, loading and unloading vessels, etc., has been designed by the Charter Gas Engine Company, of Sterling, Ill.

In the arrangement a friction-clutch is employed for connecting the drum with a large gear operated by a lever in line with the axis of the drum. The drum is carried on a hollow shaft in which a clutch-operating rod is moved back and forth by means of the levers provided. The rod is connected with toggle-joints, which force the clutch-shoes out radially against the rim of the drum.

With this method of construction, there is no end pressure on the journals while a load is being hoisted. It is not necessary for the operator to hold the lever (unless he prefers to do so for short lifts), as the clutch is self-locking. Means are provided for taking up the wear of the clutch shoes. A powerful brake is provided, so that the load can be held at any point and lowered at will.

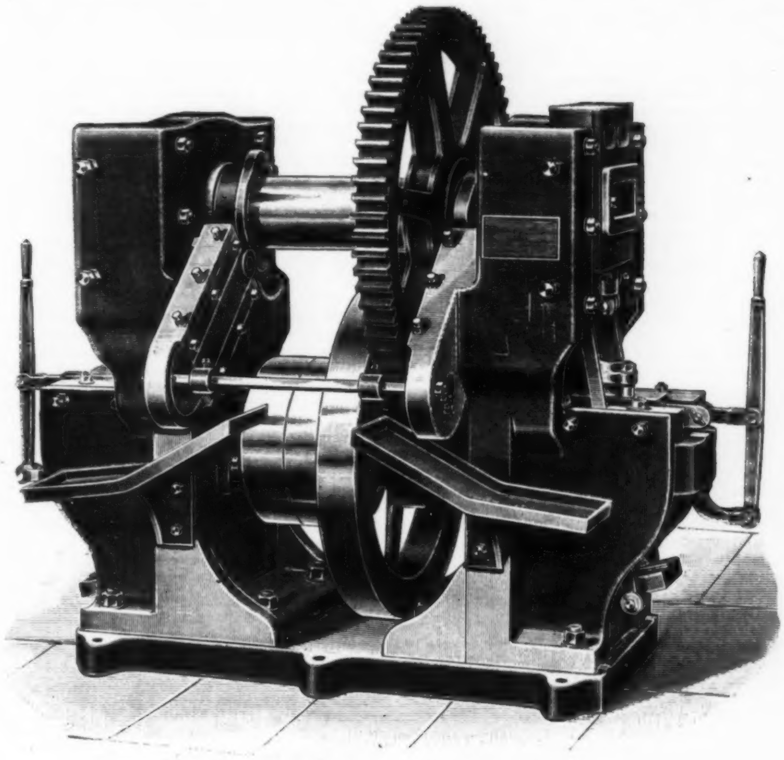
A speeding device is furnished, operated by treadle shown in cut, which device acts directly upon the governor in such a manner that the operator can control the speed of engine, varying it through a wide range of revolutions according to the necessities of the work to be done.



HOISTING DRUM DRIVEN BY A GAS ENGINE.

DOUBLE-ENDED RIVET FORGING MACHINE.

THE double-ended rivet forging machine illustrated on this page is made by Mr. Samuel Platt, of King's Hill Foundry, Wednesbury. It is made, says Engineering, in two sizes: the smaller to make rivets up to 1 inch in diameter, and the larger up to 1⅝ inch in diameter. There is a cropping arrangement fitted at each end for cutting off the iron while hot, ready for forging the rivets. The machine is strong and simple.



DOUBLE-ENDED RIVET FORGING MACHINE.

BLAST FURNACE SMELTING BY WATER GAS.

By Capt. C. C. LONGRIDGE, M. Inst. M.E., M.I. Mech. E., Etc.

IT is now four years since the writer advocated producer gas for the smelting of antimony ores. His continuous furnace, erected at Millwall, worked successfully; and it might have been thought that the economies resulting from the avoidance of oxidation and volatilization, the diminished wear and tear of the furnace lining, the lower labor charges, and the uninterrupted sequence in which the smelting and refining operations could be conducted, would have led to the adoption of this method. The trade, however, proved obdurate; and the ancient pots and solid fuel are still in use. Three years later, he drew attention to the probable advantages attending the use of producer gas in the pyritic smelting of copper ores. But nothing also in that direction appears to have been done.

Now, however, that producer gas has been supplanted by a vastly superior fuel, in the shape of the Dellwick-Fleischer water gas, the time seems opportune for once more urging the adoption of gas fuel in all smelting operations. There can now scarcely be a question that for roasting or calcining, and for reverberatory and open-hearth smelting, gas is superior to solid fuel, and for these purposes it is rapidly being applied. The only field, therefore, in which gas has yet to prove its superiority is the blast furnace. It is in a short article impossible to deal exhaustively with the subject. But by choosing as illustration say the application of water gas to lead ore smelting, most of the questions involved in the general use of this gas for the blast furnace will be met. This, therefore, seems the best way of dealing with the matter.

The reductions effected in lead ore smelting are due to carbonic oxide, incandescent carbon, and, under certain circumstances, to iron, sulphur, and metallic sulphides.* By far the most important of the reducing agents is the carbonic oxide, the action of which is modified by various factors, such as the interior shape of the blast furnace, its temperature, the blast pressure and volume, the tuyere area, the size and condition of the charge, etc. All these are sufficiently important to merit consideration. The reduction of carbonic oxide (carbon monoxide) consists in its power of robbing oxygen from a metallic oxide, thereby converting itself into carbonic acid (carbon dioxide), and the metallic oxide into metal. As carbonic acid begins to dissociate at 1200 deg. Cent., the reducing power of carbonic oxide can be active only at a lower temperature, such as exists at a certain height above the bosh or tuyere area. The location of this height naturally depends on the interior shape of the furnace. If the bosh is contracted, the blast and the charge are there more concentrated, and accordingly a thicker layer of incandescent fuel is maintained between the unmelted charge and the molten slag. The carbonic acid, generated by the fierce combustion in front of the tuyeres, in the presence of an excess of oxygen, has to pass through this layer of glowing carbon, which, rapidly absorbing oxygen, converts the dioxide into monoxide. As the bosh contraction is passed and the area of the furnace is increased, the gases rise more slowly, and the carbonic oxide has plenty of time to absorb oxygen from the ore, oxidizing itself back into dioxide, and reducing the metals.

On the other hand, the reverse takes place when there is no bosh contraction, but the furnace sides are kept straight. In this case both blast energy and charge are diffused over a wider area, consequently the layer of incandescent fuel through which the carbon dioxide ascends is thinner, less of the gas is converted into carbonic oxide, and the reducing action is, therefore, decreased. Tuyere area also affects the formation of carbonic oxide. Small tuyeres admit thin streams of air that are rapidly absorbed by the glowing coke with the evolution of carbonic oxide; large tuyeres, on the other hand, deliver more oxygen than can be absorbed by the fuel, and the gas formed is almost entirely carbonic acid, which mostly passes through the furnace as such. In the one case, therefore, the furnace atmosphere is reducing; in the other it is oxidiz-

* It seems probable that in addition to the above there is, in the crucible at least, another powerful reducer, so far unrecognized by metallurgists. This agent is a combination of caustic lime, similar in character to that formed when caustic soda is used as a flux for sulphide ores. It might have been expected that the action of a caustic hydroxide or oxide upon, for instance, lead sulphide would by double metathesis have produced sodium sulphide and lead oxide. But as a matter of fact, metallic lead, silver and gold are precipitated, even in the complete absence of metallic iron. The reducing agent, therefore, must exist among the reducing products of reaction, some of which are sodium sulphide, thiosulphate, and sulphite. The action of these, however, is not sufficiently powerful to account for the results obtained, and it seems probable that the chief agent is sodium hyposulphite ($Na_2 S_2 O_4$), which, possibly, is formed in the first stage of oxidation of the sodium sulphide. Of course, the presence of oxygen, say, from the caustic alkali, is necessary, also complete fusion of the substances. Given these conditions, a similar agent ($Ca S_2 O_4$) would be obtained when caustic lime is present in lieu of caustic soda. But whether this intermediate product would be found in the water gas-fired furnace is, perhaps, open to question.

ing. A third factor is the strength of the blast. A strong blast favors reduction, because the air pressure, forcing the carbonic acid formed in the tuyere zone into intimate contact with particles of the incandescent fuel above, even to the center of the charge, forms the maximum amount of carbonic oxide or reducing agent. A weak blast, on the contrary, does not penetrate so completely to the center of the charge, nor insure such intimate contact; and, in consequence, less carbonic oxide is generated. In connection with strong blasts, it should be remarked that their use necessitates a greater height of ore column, respectively furnace shaft, otherwise there will be a waste of fuel by the escape of overheated gases, still capable of doing drying and roasting work in the furnace. The other determining agent is the quantity and fineness of the ore. Small charges favor better mixing of the ore and fuel, and therefore the more intimate action of the reducing gas on the charge. Fine ore, also, by impeding the draught, causes the carbonic oxide to more thoroughly permeate the charge in its efforts to escape, and so to remain longer in contact with the ore. Both causes tend to promote reduction. The several conditions that favor a reducing or an oxidizing action in the blast furnace may be briefly tabulated thus:

Conditions Promoting a Reducing Effect.	Conditions Promoting a Neutral or an Oxidizing Effect.
1. High column of charge.	1. Low column of charge.
2. Contracted tuyere zone, i. e., a boshed furnace with sides expanding upward.	2. A straight-sided furnace.
3. Tuyeres of small area.	3. Tuyeres of large area.
4. Small volume of blast, at high pressure.	4. Large volume of blast, at low pressure.
5. Small charges of moderately fine ore.	5. Large charges of coarse ore.

The reducing or the oxidizing action of the blast furnace is thus seen to be dependent on various factors, by which the formation of carbonic oxide is regulated. With the use of water gas, the necessity for these regulating factors vanishes, because the carbonic oxide is produced outside the furnace, and any difference in the temperature and the atmosphere within the furnace is merely a question of the respective quantities of gas and air admitted. The use of the furnace is therefore extended, and its management simplified.

But water gas has other advantages. One of these is the ease with which the fuel is burnt exactly where it is required, and the fusion zone is circumscribed within the desired limits. Where solid fuel is disseminated with the charge throughout the furnace, any irregularity of the blast, etc., may cause combustion to creep upward, burning the fuel where it is not only useless but absolutely prejudicial to the proper running of the furnace. With water gas this is impossible, for the charge contains no fuel.

A further advantage is the cleanness of the fuel. Water gas is not only easily purified from sulphur, which, for iron and steel smelting, is of importance; but it is free from ash, which for every kind of smelting is an undoubted benefit.

Touching the important question of economy, there are, of course, no actual data on which a verdict can be formed. Nevertheless, there are numerous facts indicating the economical superiority of water gas over coke. The Dellwick water gas represents the possible utilization of 80 per cent. of the calorific value of the fuel; it can be stored without deterioration; it is a pure and ashless fuel; it can be applied without waste, and with almost theoretically perfect combustion; it involves no labor in charging; it admits of easy furnace regulation and safe running; and, owing to the absence of dust and ash, it increases the output, and probably lessens the wear and tear of the furnace. Besides these notable differences, the water gas supplies on an average about 51 per cent. of hydrogen, which, acting as a reducing agent, should tend to largely augment the furnace capacity. It is noteworthy that in open-hearth steel smelting, and in numerous other applications, water gas has proved to be more economical than solid fuel.

It would be manifestly unfair were the writer to conclude without referring to the difficulties that attend the application of water gas to the blast furnace. An important difficulty, and one that affects the use of both charcoal and of oil, is the inability of such fuel to support a heavy ore burden. Even hardwood charcoal is deficient in this quality. Petroleum, notwithstanding its successful use, especially in Russia, for open-hearth and crucible steel furnaces, for puddling and other furnaces, for drying ovens, kilns, and cementing furnaces, has so far failed in the blast furnace, solid fuel being found essential to the necessary loosening of the ore column. How does water gas meet this difficulty? As already explained, a high charge column, in lead and copper smelting, is merely an expedient to attain certain chemical reactions; but these are given by water gas without the necessity of recourse to any such means. Hence, in water gas smelting, a high ore column and heavy burden are not required. Moreover, the fuel, being in a gaseous form, will penetrate when even the oil spray will fail. With fairly coarse ore or bricked fines, a furnace of moderate height and width, and possibly a double or treble tier of gas inlets, the writer thinks that this difficulty will be likely to prove more fancied than real.

As a further objection, it might be thought that the gas flame would be too short to properly cover the furnace area, thus producing merely a local heat immediately in front of the gas inlets. It is, however, stated by Mr. Dellwick that this, at least in the case of the open-hearth furnace, is not so. When the heat reaches the temperature of dissociation of steam or carbonic acid, the zone of combustion extends till the furnace becomes equally heated, the flame being visible only as it leaves the furnace. In fact, it has turned out that the only defect of the first furnace constructed was that it was too short. This corresponds with the writer's own experience.

The presence of so large a quantity as 51 per cent. of hydrogen in the water gas suggests another difficulty. If the hydrogen combines with oxygen low down in the furnace, will it not create a highly oxidizing atmosphere in the upper portion? This depends entirely on the volume of the blast, and can be varied at will. By furnishing the hydrogen with oxygen from the blast, an oxidizing atmosphere will be produced, and may enable more raw ore to be smelted in the charge than is now the case. On the other hand, by curtailing the volume of the blast and forcing the hydrogen to unite with the oxide of the metallic oxides, a very reducing atmosphere can be maintained. The presence of the hydrogen, therefore, is really an advantage.

It is possible that the regulation of the rate of fusion to that of reduction may occasion some trouble, which, however, practice should enable the smelter to overcome.

Another point of interest, on which, however, it is impossible to do more than touch, is the effect of using water gas as supplementary fuel to coke. In such a case the water gas burnt in the tuyere zone would produce carbonic acid and steam, which, ascending through the layer of incandescent fuel, would practically be reconverted in water gas. The only advantages of such a combination would be an intense local heat in the fusion zone, with a heating and highly reducing atmosphere in the upper portion of the furnace.

There are so many possibilities opened up by the invention of improved water gas, that it is to be hoped that some serious trials of the value of this fuel for blast furnace smelting will at length be made.—The Engineer.

THE SENSITIVENESS OF METALLIC SILVER TO LIGHT.*

THE paper is a continuation of that read before the Royal Society on May 31, and contains an account of further experiments on the production of visible photographic images upon plain silver surfaces by the action of solar radiations. The author has found that such visible images are formed when pure silver foils or silvered glass are exposed to sunlight in exhausted glass tubes, and, apparently, more readily in the presence of watery vapor. Invisible, but developable, images were readily obtained in exhausted tubes in which no signs of the presence of moisture were apparent. By prolonged exposure a visible change also takes place. When thin films of silver on glass have been fully exposed in sunlight, the action has been found to penetrate the film and produce a distinctly visible image at the back as well as on the face, the exposed parts appearing always lighter than the unexposed.

Fresh experiments with silver plates used as anode and cathode in a decomposition cell containing distilled water, through which a weak current was allowed to pass, showed that the pale gray deposit on the cathode and the dark olive yellow coating on the anode were both quite sensitive to light, and appeared lighter by exposure, in a manner somewhat analogous to that observed on silvered glass or plain silver foils exposed to light. It was noticed that the visible images were not dissolved away either by the usual photographic fixing agents or by dilute nitric acid.

A very curious action of light upon glass has also been observed. In this case a silvered glass plate was exposed for about a month under a cut-out screen of thin aluminium, the unsilvered side of the glass being in contact with the aluminium and not protected from the air by a covering glass plate. After exposure the plate was put aside for a few days, with the exposed glass side in contact with the silvered surface of another piece of polished silvered glass, which was then found to have received an impressed image from the glass of the design cut out of the aluminium screen. The image was quite visible, clear, and sharp, and somewhat similar to the images directly impressed by light, though it had not the same appearance of being bleached out, when examined by reflected light. Several days afterward a second similar image was produced in the same way by contact with the glass upon another freshly polished silvered glass plate, and no doubt several more could be produced in the same way.

These new experiments seem to show that the images formed by the action of light upon plain silver surfaces are due more to molecular or physical changes than to chemical decomposition, though the latter may also probably come into play in the presence of watery vapor, or other conditions favoring oxidation and reduction of the metallic surface. The author is continuing the investigation.

PRODUCTION OF ROENTGEN RAYS.

WHEN a spark gap is introduced in a Roentgen ray circuit, the maximum gaseous pressure at which X-rays can be produced is increased. According to A. Winkelmann, the maximum pressure attainable depends upon the length and position of the spark gap, the nature of the gas and the dimensions of the tube. At the highest pressures, Roentgen rays are only seen when the spark gap lies between the cathode and the induction coil. As the pressure decreases, rays begin to appear also when the spark gap is next the anode; but they are feebler than in the other arrangement. At low pressures the influence of the position of the spark gap becomes less pronounced, and finally disappears. Hydrogen yields Roentgen rays at greater pressures than air or carbonic acid. The latter allows the least pressure, but its difference from air in this respect is not great. The admissible pressure may be considerably increased by making the tube narrow. Thus in a tube only 5 millimeters in diameter it was found possible to increase the pressure of the air contained in it to 10 millimeters of mercury, and yet obtain effective X-rays. But a further narrowing has the contrary effect, and in hydrogen the maximum pressure of 30 millimeters is already reached in a tube 1 centimeter in diameter.—A. Winkelmann, Ann. der Physik, No. 8, 1900.

Self-Igniting Mantles.—According to Killing, a fabric of platinum wire and cotton thread is sewed or woven into the tissue of the incandescent body; next it is impregnated with a solution of thorium salts and dried. The thorium nitrate in glowing gives a very loose but nevertheless fireproof residue. A mixture of thorium nitrate with platinic chloride leaves after incandescence a fire-resisting sponge possessing to a great extent the property of igniting gas mixtures containing oxygen. Killing employs a mixture of 1 part of thorium nitrate to 2½ parts of platinic chloride.—Chemiker Zeitung.

* Abstract of a paper read before Section B of the British Association, at Bradford, by Major-General J. Waterhouse, I.S.C.—Journal of the Society of Arts.

TRADE NOTES AND RECEIPTS.

Graphite Paste for Stove Polish.—

Ceresine	120	grammes.
Japanese vegetable wax	100	"
Turpentine oil	1000	"
Best lamp black	120	"
Finely levigated graphite	100	"

Unite ceresine and wax by melting and add to the semicooled liquid mass, just after removal from the fire, the lamp black and graphite ground in the turpentine oil, stirring until completely cooled.—Seifensieder Zeitung.

Sulphur Beds in Russia.—The rich sulphur beds in Russia have only been discovered in recent times. At various times small works for producing the sulphur were erected; the largest of them was at Daghestan in North Caucasus. Here the maximum production amounted to 1,500 tons (1888) but the work has been abandoned. The beds of Daghestan are very extensive and have 20 per cent. of sulphur; their geological character resembles that of the Sicilian beds, which only contain 14 to 17 per cent. of sulphur on an average. The works were abandoned owing to the unfavorable situation. At the present moment only two establishments are running in Russia, producing less than 1,000 tons of sulphur together, which only constitutes 5 to 10 per cent. of the requirements of the country. The sulphur beds which have recently been discovered in Transcaspia, Asiatic Russia, are the second largest in the world. On a territory of 23 square miles (metrical) are several indentations. The beds are situated 100 miles from Khiva on the Amur and 170 miles from Askhabad on the Transcaspian Railroad. Mayeffsky and Konshin report fully on the latter beds. They lie next to a place called Khirk-Choulba, and consist of various groups of hills running along the Ungus Valley. The sulphur is practically exposed. The gangue is sandstone and contains 60 per cent. of sulphur on an average. Shafts are unnecessary. The yield in sulphur is estimated at nine million tons.—Chemiker Zeitung.

A New Lacquering Process.—The problem of shortening the drying process of lacquers without detracting from the elasticity and hardness of the coating is known to play an important part in the varnish industry.

Besides chemical admixtures giving off oxygen (siccatives), heat is the chief factor employed for this purpose, and for this reason there are varnish ovens in which, according to the composition of the varnish, a heat of 30, 60, 100, and even 300 and 500° Celsius is generated.

As a general rule, the observation has been made that the quality of a varnish improves with the length of time it requires for hardening, under equal conditions of temperature, and for this reason lacquers which dry rapidly at ordinary temperatures, and without any special assistance, are not always very durable.

An especial means of accelerating the drying is exposure of the lacquered articles to the sun, and this method is used especially in the manufacture of patent leather, which is known to be able to stand an increase in temperature only within very moderate boundaries. It is in the varnishing of leather that it has been shown that the rays of the sun have not only the effect of hastening the oxidation process, but also of materially improving the lacquering, which improvement consists in that the varnish becomes harder, hence more resisting, remaining at the same time elastic and proof to cold.

In the endeavor to find an artificial substitute for the sun's rays, which, though cheap, are not always at hand, it became, of course, first necessary to study the chemical process occasioned by the rays, and it was natural to liken the action to the bleaching effect of the sun.

As regards the latter effect, it has been assumed for a long time that it is caused in consequence of the formation of ozone by the sun's rays, since the artificial employment of ozone gives very good results in bleaching.

The presumption that the formation of ozone from the oxygen of the air also becomes a factor in the drying of lacquer by the sun is strongly supported by the fact that ozone, the active oxygen, excels everywhere by especially great oxidizing power, and practical experiments with artificial ozone have actually shown that its effect in the drying of varnishes is very similar to that of the sun's rays. The oxidation is hastened, and the quality of the varnish coating is at the same time materially improved.

Ozone is known to be oxygen in a condensed form. Three atoms of oxygen take up, as ozone, only as much space as two atoms of oxygen in the ordinary state, and the fact that three atoms belong together further distinguishes it from ordinary oxygen, as contained in the air, in which only two atoms congregate when it enters into chemical combinations with other bodies.

The strongly oxidizing qualities of ozone are also utilized, among other instances, in the manufacture of linoleum, for a quicker oxidation of the linseed oil, by heating in thickening.

For the purpose of utilizing the good qualities of ozone for the drying of lacquers, Carl Hoch, at Griesheim on the Rhine, has devised a contrivance of the following arrangement: In a comparatively small clay apparatus air is heated and cleaned by a special process, prepared for the formation of ozone, and then strongly mixed with ozone by the use of chemical substances. The air thus prepared is conveyed by a pipe conduit to the lacquering oven and passes through it, so that the surfaces of the lacquered articles are permanently placed in contact with fresh ozone. In this manner, lacquers which otherwise require 300° of heat are said to be dried in a short time at 30° to 35° C. with excellent hardness and elasticity.

This process therefore is suitable for lacquering metal goods, especially sheet metal ware soldered with tin as well as for any other material, especially in the manufacture of patent leather or where articles are to be lacquered which besides metal also consist of readily combustible materials such as wood and leather. It doubtless marks a considerable progress in the perfection of lacquering methods, which is not without importance for the lacquer manufacture.—Georg Rothgiesser, in Farben Zeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Manufacture of Patent Fuel in Wales.—In my report on "Coal Briquettes in Wales," published in March, 1899, says Consul Daniel T. Phillips, of Cardiff, I gave an elaborate statement describing the various processes for manufacturing patent fuel, or coal briquettes, from soft coal. I will now describe the agglomite process of manufacturing patent fuel from both the anthracite and bituminous mineral, specimens of which may be seen in my office.

The agglomite process of manufacturing patent fuel from anthracite and bituminous minerals is entirely different from any other. By this method, the coal and agglomerants are chemically mixed while under the influence of heat and pressure, in a sealed vessel, by which a new fuel compound is produced.

The process is as follows:

The coal and agglomerants are mixed and ground in a dry state. If tar or pitch or other liquid substances are used, they may be subsequently added; then the prepared material is put into a hopper attached to the end of a horizontal tube. The opposite end of this tube is connected with the briquette press. A worm is kept constantly revolving in the tube, conveying the material through the tube and feeding it into the pressing ram chamber. The tube passes through a small furnace, which enables the material to become heated to a temperature of 500° or 600° F. The gases evolved cannot escape; hence the pressure produced within the tube is shown on an attached gage to be about 10 pounds per square inch. Practically, the tube is an automatically sealed vessel, for the closely packed mass of coal materials fed from the hopper into one end of the tube by the revolving worm and the hot plastic mass fed out by the same worm into the press chamber at the other end of the tube is so closely blocked up by the passage as to overcome the internal pressure of 10 pounds per square inch created by the hot gases. These gases, under pressure, permeate the hot plastic mass which is being turned over and over as it slowly travels along the sealed tube. Tar, as well as pitch, can be used as an agglomerant. Indeed, the use of tar, which is considered cheaper than pitch, affords opportunities for many possible new chemical combinations in the manufacture of agglomite. There is no question that a form of tar distillation goes on in the tube with the degree of heat employed; and that with such distillation carried on under pressure numerous well-known substances are broken up, rearranged, and are intimately incorporated with the particles of coal in a way which is not possible under any other fuel manufacturing system.

Of the proximate composition of coal, comparatively little is known. When coal is subjected to great heat, it is known that gaseous hydrocarbons are produced, and then chemical reactions take place; but the composition of the gaseous hydrocarbons varies according to the temperature to which the coal is subjected.

The practical value of a fuel largely depends on its ability to produce gases, which, properly burnt, yield considerable heat. Agglomite fuel possesses this feature, due first to the dissociation of gases under the combined influence of heat and pressure; secondly, to the ultimate chemical rearrangement of gases and solids, while being gradually condensed and cooled previous to passing into the pressure chamber of the briquette press. The process, mechanically and commercially, is full of chemical problems and secrets, for which reason it is advisable that our American merchants who may be inclined to go into the business should familiarize themselves therewith before embarking on the enterprise of manufacturing anthracite fuel.

Millions of tons of anthracite-coal dust now thrown away can be successfully utilized in this manner. It will not take long for our quick sighted American citizens to master details. It will be to their advantage to know that a much smaller percentage of agglomerating material than is usually employed will suffice, without impairing the quality or appearance of the fuel.

Tar can be employed with advantage, both for heating power and from an economical point of view. With the object of ascertaining the quality and action of agglomite fuel, made from an inferior small coal, Mr. James Stevens, M.E., inspected the experimental plant at work. He makes the following statement:

"The briquette press is something like the old form of a Bourriez press, but has a short horizontal mold only 8 inches long. It is capable of producing about 3 cwts. per hour and is driven by a small engine exerting 8 actual horse power. The pressing ram is 3-inch diameter, making twenty-three strokes per minute and exerting a pressure of 680 pounds per square inch on the fuel. The material is fed by the worm of the heating tube into a closed chamber between the pressing ram and the mold. The mold consists of two semicircular plates 3 inches internal diameter by 8 inches long, pressed together by two levers and slightly tighter at the outer end, so that, while the pressing ram keeps pressing fresh charges into the taper mold at a pressure of 680 pounds per square inch, the material is gradually being more and more compressed, resulting in a very compact fuel, with bright polished sides. While the material is passing through the mold—occupying a period of some twenty-eight seconds—the levers subject it to a continual pressure of 2,376 pounds on the circumferential area of the fuel, or to an average pressure of 31 pounds per square inch for twenty-eight seconds.

"The agglomite made in the above plant consisted of 88 per cent. of small coal produced from the 4-foot Glyngwernen seam, having a value of 4s. to 4s. 6d. (97 cents to $1.19) per ton delivered in Swansea, 8 per cent. of pitch and 4 per cent. of tar. The proportion of agglomerants is high, and could be with advantage greatly reduced by using a better quality of coal. The coal contained 9·52 per cent. of ash, but repeated laboratory tests give as much as 12·5 per cent. The volatile matter was said to be from 13 to 14 per cent.

"The trial was made in a Galloway boiler ten or twelve years old, but in good and clean condition, and connected to a chimney which exerted a natural draft of 0·45 inch. Cold water was filled into the boiler till it stood at the working water level of the boiler. A fire was then made and the water raised to boiling point. The greater portion of these fires was then withdrawn and a trial commenced, the water being maintained at one level by allowing the contents of a cask to run into the boiler when required. These casks were fixed above the boiler and fitted with supply and delivery pipes and valves, so that the cask could not be emptied till it was exactly full. The water ran direct from the casks into the boiler through the manhole. In order to be quite sure that none of the water could be lost by being carried away by priming, the manhole cover was kept off and the steam allowed to escape direct into the atmosphere.

"The casks employed for the above purpose were carefully weighed when empty and when full, and the amount of water fed into the boiler is therefore absolutely correct.

"The fuel ignited very readily and burned with a white flame of great heat with much briskness. The briquettes slowly opened out on the grates and presented an appearance, when partly burnt, like lumps of coral. There was no tendency to melt, and only 1·19 per cent. fell through the grate bars in the shape of ash. Owing to the excess of dirt in the coal, the clinker was 7·19 per cent.; this, of course, can easily be avoided in a better class fuel. The boiler was fired twenty times in six hours, but no further attention on the part of the stoker was necessary.

"The smoke produced was very satisfactory, the amount visible after each firing being faint and lasting about one minute.

"A block of agglomite was immersed in water with the following satisfactory results:

Weight of block	31·75
Weight of block after 1 hour's immersion	31·75
Weight of block after 20 hours' immersion	31·95
Weight of block after 26 hours' immersion	31·95
Weight of block after 164 hours' immersion	32·05
Weight of block after 242 hours' immersion	32·07

"At the end of 242 hours, the block was found to be as hard as when first immersed."

The weight of a cubic foot, calculated from these blocks, is 77·89, pounds, equivalent to a specific gravity of 1·25. This is satisfactory when it is considered that the specific gravity of patent fuel varies from 1·18 to 1·22.

The average of a series of tests with Thompson's calorimeter proved that the calorific value of the fuel was 11·08 per cent. higher than that of the coal from which it was made. This instrument gave an average theoretical evaporation of 14·9 pounds of water per pound of fuel from and at 212° F.

A fair average evaporation of Welsh steam fuel is 9 pounds of water per pound of fuel from and at 212° F. On reference to the trial table which I submit, it will be seen that 1 pound of agglomite made from inferior small coal evaporated over 10 pounds of water from and at 212° F.

Mr. Stevens declares that in his opinion the "agglomite" process of making patent fuel, when carried out in suitable machinery, is superior to any of the processes known to him.

STEVENS'S TABLE SHOWING RESULTS OF STEAM TRIAL.

Duration of trial, 6 hours.
Temperature of atmosphere, 52° F.
Type of boiler used for trial, Galloway.
Boiler dimensions, 26 feet in length by 6 feet 6 inches in diameter.
Diameter of furnaces (2), 2 feet 7½ inches.
Number of Galloway cone tubes, 27.
Dimensions of grates, 7 feet by 2 feet 7½ inches.
Total grate area, 36·75 square feet.
Total heating surface, 766 square feet.
Total amount of fuel consumed, 2,385 pounds.
Total amount of fuel consumed per hour, 397·5 pounds.
Total amount of refuse fallen through grates, 28·5 pounds (1·19 per cent.)
Total amount of clinker, 171·5 pounds.
Total percentage of refuse in the fuel, 8·39.
Net amount of combustible, 2,185 pounds.
Average temperature of feed water, 48° F.
Actual amount of water evaporated, 20,559 pounds.
Pounds of water evaporated per pound of fuel, 8·62.
Pounds of water evaporated per pound of combustible, 9·41.
Pounds of water evaporated per pound of fuel from and at 212° F., 10·085.
Pounds of water evaporated per pound of combustible from and at 212° F., 11·009.
Pounds of fuel burnt per square foot of grate per hour, 10·82.
Number of times each furnace was fired, 20.
Draft at foot of chimney in inches of water, 0·45.

There is no reason why a pound of bituminous or anthracite coal dust should be wasted, nor why the patent-fuel industry should not succeed in the United States. All that is wanted is a little capital, a little common sense, a little courage and perseverance.

Money and Coinage in Spain.—The present coinage of Spain is under the reform law of 1868, which took effect the 31st of December, 1870, with its several amendments. The law of 1868 created the monetary unit of 1 peseta (19·3 cents) in place of the old unit of a real (about 5 cents), and made weights and fineness of gold and silver to conform with those of the Latin Union.

In 1876 the 20-peseta gold piece was discontinued, and a piece of 25 pesetas decreed in its stead.

In 1881 the branch mint in Barcelona—where the coinage of bronze was done—was suspended, and since that time all coinage has been done in the Casa de Moneda (the mint) in Madrid.

The operations of the mint are not available for detailed report. It is, however, a fact that it is working constantly, coining silver to its capacity; and, accordingly, in the past ten or more years, not only have practically all of the old coins been reminted, but a large sum of money has been coined from silver bullion, from which, it is currently reported, the profits to the government amount to a large sum annually.

By chance I obtained the loan of a "Memoria" in pamphlet form, issued in 1895, containing an official compilation of coinage from 1869 to 1893, inclusive.

During that period the coinage of the 20-peseta gold piece was effected in only three years—1889, 1890 and 1892—and the total number of pieces coined was 5,650,083. In the same period there were only 123,869 10-peseta gold pieces coined, and those in the two years of 1878 and 1879.

Of silver, during the same period, there were 140,584,928 5-peseta pieces coined, which coinage was carried on in each year, except 1869 and 1881. Of 2-peseta pieces there were 69,517.913 pieces coined in the years 1871, 1873, 1874, 1875, 1879, 1881, 1882, 1883, 1885, 1889, 1891 and 1892. Of the 1-peseta pieces there were 47,839,924 pieces coined in the years of 1869, 1870, 1871, 1873, 1876, 1881, 1882, 1883, 1884, 1885, 1886, 1889, 1891 and 1893. Of the half-peseta pieces there were 15,386,434 pieces coined in the years of 1870, 1881, 1885, 1889 and 1892. In 1871 an exceptional coin of the value of one-fifth of a peseta was coined to the number of 5,091 pieces only.

Since 1893, as before intimated, the coinage of silver has been constant and in large amounts, so much so that the money in circulation is mostly of new coinage, and a goodly portion even bears date of 1900, but no official figures are obtainable at this time.

The coinage presses are stated to be of the Thonnelier invention, of which there are six large ones and eight medium ones, and one of a German type, name not given; also four presses for coinage of small pieces. With these the capacity of the mint is 100,000 large coins, 200,000 medium coins and 150,000 small coins.

The durability of the dies used in coinage may be of interest, and is stated as follows: In the coinage of the 20-peseta gold pieces the average is 15,188 to a pair of dies; in the 5-peseta silver pieces, 8,545 to a pair of dies; in the 2-peseta pieces, 9,032 to a pair of dies; in the 1-peseta pieces, 8,929 to a pair of dies; and in the half-peseta pieces, 7,242 to a pair of dies.

The coinage of the 25-peseta pieces was carried on only in the years 1877 to 1886, both inclusive, but to the extent of 29,984,073 pieces.

The weight of the 25-peseta gold pieces coined averaged 1·0005, and the fineness 899·8; the 10-peseta gold pieces averaged 0·9996 and 899·99, respectively.

The weight and fineness of the silver coinage averaged, respectively, as follows, viz.: Five peseta pieces, 0·9993 and 0·900; 2-peseta pieces, 0·9993 and 0·8349; 1-peseta pieces, 1·000 and 0·835; and the half-peseta pieces, 0·9990 and 0·8351.

The amount of copper or bronze coins in circulation can only be estimated at about 70,000,000 pesetas, nominal value, or about 3 to 4 pesetas per capita of the population.

The money in circulation consists of Bank of Spain notes, silver and copper, gold being 27 to 28 per cent. premium.—Dwight T. Reed, Vice-Consul at Madrid.

Orris-Root Trust.—Consul Marshal Halstead writes from Birmingham, August 22, 1900:

The British vice-consul at Leghorn reports that a syndicate, supported by a powerful bank, has recently secured the whole of the Veronese orris-root crop and nine-tenths of that of Florence, and that the small quantity of Florence root still in the growers' hands is being offered at enormous prices. Orris root, he states, is used as the basis of all perfumes by the manufacturers of England, France, and Germany, and is obtainable only around Florence and in the neighborhood of Verona. Importers must look, therefore, to two small districts in one country for the whole of their supplies of an indispensable article. Continuing, the vice-consul says:

The syndicate itself is still holding its stocks and apparently declines for the present to sell. Representatives of a large perfume manufactory of Grasse recently endeavored to obtain a small quantity, but without success. There are now perhaps not 50 tons in the whole of Leghorn. French manufacturers, however, appear to be fairly well stocked and are suffering no present inconvenience, but the day will come when they cannot get on without orris root and they will have to pay heavily for it. Some dealers in the root, however, think that the advance in price is on the whole for the interest of all concerned, as, had the prices remained at the level of last year, many large growers would have given up planting. Orris root is a commodity that is subject to the most singular fluctuations in price. A fair average price is £50 ($243·32) per ton. In 1891, as much as £120 ($583.98) per ton was paid, and in 1898 as little as £26 ($126.52).

Electricity on German Farms.—Under date of August 23, 1900, Consul Hughes, of Coburg, says:

In this and neighboring parts of Germany considerable attention is being paid to electrical appliances that can be used on the farm. Near Ochsenfurt, in Bavaria, a company composed of landowners and small farmers has been organized for the establishment of an electrical system for use on their farms and villages. The power is to be generated by steam and water, and the current to be distributed from a central station to the places at which it is wanted. Substations are to be established at given points, with the necessary apparatus for connecting with the farm or other machinery, and also for lighting purposes in the houses, offices, roads and village streets.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

ELECTRIC MACHINES AT THE EXPOSITION OF 1900.

SPEAKING in a general way, we may say that the electric exhibit, properly so called, at the Exposition of 1900 is noticeable by a large number of machines of every power from 1 to 3,000 watts with continuous, alternating, and polyphased currents. Many improvements of all kinds have been introduced into the construction of these apparatus, which, eleven years ago, had scarcely acquired, officially, the freedom of the city of Paris. In what follows, we shall not meet with any great novelties, if we except M. Leblanc and M. Boucherot's compound alternators.

We shall examine the principal machines in succession, in following the order observed in our article upon steam engines, as regards the groups of generators of electricity, and in adding, in measure as we come to a manufacturer, a description of his various machines.

The Decauville establishment, which has for some years been devoting itself to electric construction, shows us a series of machines of various powers, and, principally, two multipolar dynamos of 450 kilowatts each at 50 volts and at 75 revolutions a minute. The armature wires are wound upon a multipolar drum, and the inductor has consequent poles.

The Fives-Lille Company is grantee in France of the Allgemeine Elektricitäts Gesellschaft, and therefore exhibits all the types of the machines of this large establishment. It has, however, constructed on its own account a triphased current alternator of 800 kilovolt-amperes, at 2,200 volts and of a frequency of 50 periods per second. The armature completely envelops the inductor. Cast iron segments, four in number, connected with each other, form a ring in the interior of which the armature plates are mounted. These latter are composed of plates of sheet iron 0·02 of an inch in thickness, insulated from each other by tissue paper, and squeezed together. There are apertures arranged for the passage of micanite tubes designed to receive the winding. The cores of the inductors, 76 in number, are mounted upon the rim of the fly wheel of the steam engine.

The Société Alsacienne des Constructions Mecaniques, of Belfort, has mounted at the Exposition various models of the continuous current machine, of what is called the external collector type.

The French Thomson-Houston Company and the Postel-Vinay establishment exhibit a triphased current alternator of 5,500 volts and 25 periods per second, and various other models of continuous and polyphased current machines of all powers.

The Breguet establishment, which has been constructing dynamo machines since 1873, exhibits a series of two-pole models for feeble powers, and of several poles for higher powers. Notable improvements have been introduced into all these dynamos with the object of protecting the armature and obtaining a stationary keying of the brushes and prevention of sparks upon the collector. We must not forget to speak of the new simple and polyphased alternating current material which has just been devised by the Breguet establishment.

Let us mention particularly a compound alternator of 736 kilowatts (Boucherot system), the object of which is to maintain a constant tension at the terminals, sensibly independent of the discharge of the alternator, by means of a special exciting dynamo with sinusoidal windings and a compounding transformer. The same establishment has likewise mounted several dynamo machines and alternators of various powers directly upon Laval steam turbines.

In the exhibit of the A. Grammont industrial establishments, we find a triphased current alternator of 600 kilowatts at 2,400 volts, at a frequency of 50 periods per second and an angular velocity of 94 revolutions per minute. The excitation current of this alternator is produced by a compounding exciting dynamo of the Hutin and Leblanc system controlled by gearing, and the object of which is to maintain a constant tension at the terminals of the alternator, whatever be its discharge.

The Farcot establishment exhibits a biphased current alternator of 750 kilowatts at 2,200 volts per phase and a frequency of 42 periods per second. This apparatus is provided with the Hutin and Leblanc device, to permit of assuring the coupling in parallel.

Messrs. Schneider & Company have constructed a triphased current alternator of 840 kilowatts at 3,000 volts and a frequency of 50 periods a second. They are, moreover, grantees of all the patents on the machines (Thury system) of the Compagnie de l'Industrie Electrique of Geneva. In all this material, we remark continuous current bipolar and multipolar dynamos, as well as bi- and triphased continuous current alternators, revolving iron alternators, and, in particular, multipolar machines up to 3,000 volts with continuous currents for distribution at a constant intensity and at a high tensión.

The "Eclairage Electrique" establishment, which, since 1877, has continuously occupied itself with applications of electric energy, exhibits a complete collection of apparatus for the production of energy, such as continuous current dynamos of the Labour type, bi- or multipolars, of all powers, for distribution; three or four wire dynamos for distribution, and dynamos for traction, electrolysis, and metallurgy. Again, we find Labour alternators giving simple or polyphased currents, with movable or fixed armature; dimorphous dynamos giving both continuous and alternating currents, simple, biphased, or triphased. We remark in particular a Labour alternator of 1,200 kilovolt-amperes at 3,000 volts and at a frequency of 50 periods per second; and another Labour alternator of 200 kilovolt-amperes at 30,000 volts.

In the exhibit of the Compagnie Générale d'Electricité of Creil (Daydé and Pillé establishments) likewise are found some models of bi- and multipolar machines of all powers, not to forget the fine 1,000 horse power continuous current machine of the group of electric generators already mentioned.

We must not forget to mention several other well known manufacturers, such as MM. Hillairet, Sautter, Harlé & Company and the Compagnie Générale de Nancy.

Hillairet, Sautter, Harlé & Company, aside from their continuous current material, already well known in the electric industry, aside from their specialties relative to the lighting of lighthouses and ships, have, at the advice of M. Blondel, established a full series of very remarkable triphased current apparatus. Among these we may mention some triphased current alternators of from 3,000 to 8,000 volts, with revolving armature.

The Compagnie Générale de Nancy likewise manufactures a very full line of continuous alternating and polyphased current dynamos of 280 kilowatts at 3,000 volts and of a frequency of 50 periods per second, actuated by a Weyher & Richemond steam engine.

The Jacquet Brothers exhibit a full line of continuous current electric machines of 110, 220, and 440 volts, the construction of which leaves nothing to be desired.

The Compagnie Electromecanique is the depository in France of the Brown & Boverie establishment of Switzerland. It exhibits several interesting models of dynamos and alternators.

In the foreign sections also is the material very complete, and we everywhere find continuous, alternating, and polyphased current machines of all types and all powers. We shall be content to mention the most striking of these. In the first place is the triphased current alternator of the Allgemeine Elektricitäts Gesellschaft, of Berlin, which is exhibited in the German annex. This alternator gives 3,000 kilowatts at 6,000 volts at 83 revolutions a minute and a frequency of 50 periods per second. It is provided with the Hutin and Leblanc device for assuring its running in parallel. The inductor has 72 poles and a diameter of 24·25 feet. The total diameter of the alternator is 28·2 feet.

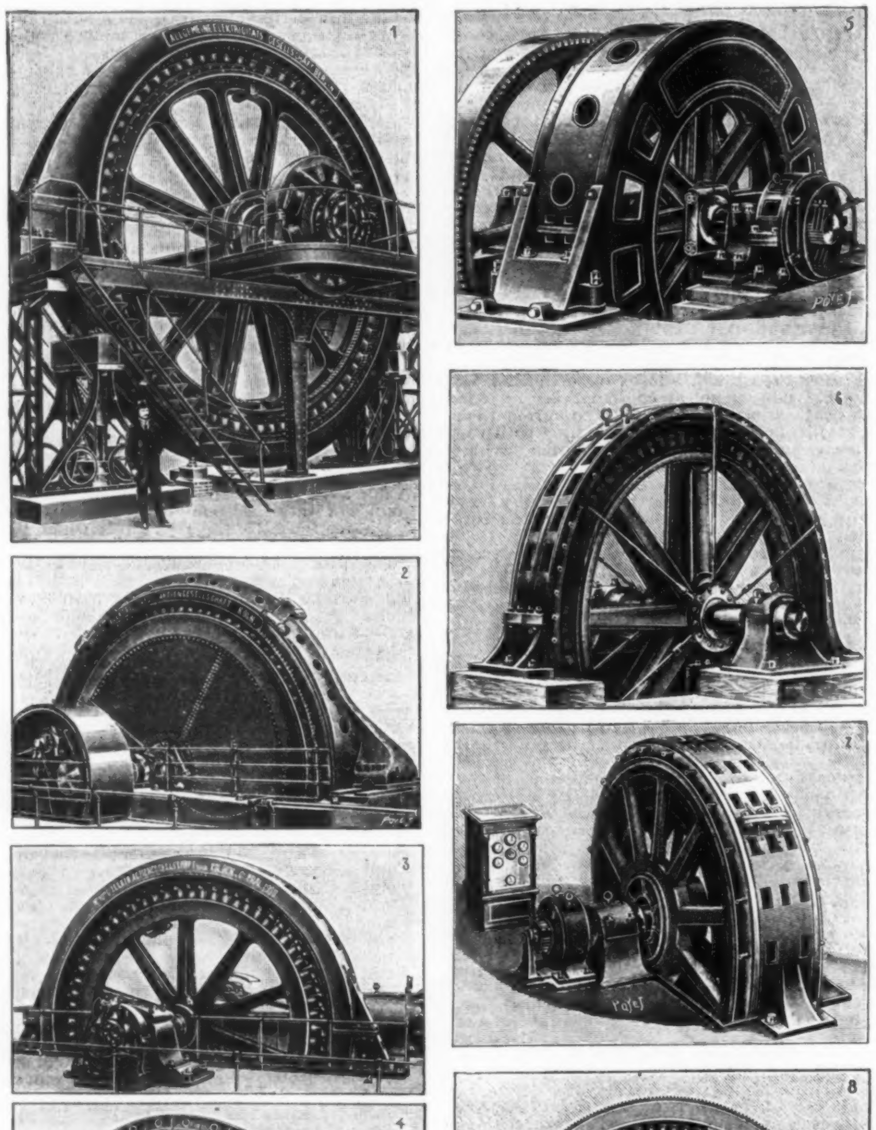
Afterward comes the Helios alternator, which, through a special winding, produces a simple and an alternating current (1,200 kilovolt-amperes), and also triphased currents (1,500 kilovolt-amperes). The angular velocity is 72 revolutions a minute, and the effective difference of potential is 2,000 volts.

The Siemens & Halske establishment, of Berlin, whose reputation has already been made in all branches of electric energy, exhibits a triphased current alternator which has particularly excited the attention of electricians. This alternator, actuated directly by a Borsig steam engine, gives a power of 2,000 kilovolt amperes at 2,200 volts per phase.

The Elektricitäts-Aktien-Gesellschaft, formerly Schuckert & Company, is one of the largest electric manufacturing houses in Germany. Its exhibit is very extensive, especially as regards the various generators of electric energy. We have a striking example of the products of this house in a triphased current alternator of 850 kilowatts at 5,000 volts and 50 periods per second.

The Société Anonyme d'Electricité, formerly Lahmeyer & Company, shows us a triphased current alternator of 1,000 kilowatts and a continuous current dynamo of 350 kilowatts.

This house is likewise constructing all kinds of types of continuous current dynamos with three pillow blocks or two supports for all powers with two or more poles. The triphased current generators are multipolar machines with revolving inductors, and armature fixed externally.



1. The Elektricitäts Gesellschafts Alternator. 2. Helios Alternator. 3. Kolben Alternator. 4. Oerlikon Alternator. 5. Siemens & Halske Alternator. 6. Schuckert Alternator. 7. Lahmeyer Alternator. 8. Alternator of the Industrial Company of Liege.

ELECTRIC MACHINES AT THE EXPOSITION OF 1900.

The Société Anonyme Electricité et Hydraulique, of Charleroi, which now has manufactories in France, at Jeumont (Nord), has been constructing dynamos since 1879. At that epoch, M. Dulait employed but two workmen. The works have rapidly developed, and in the Exposition we find two triphased current alternators of 1,000 kilowatts at 2,200 volts and 50 periods per second, and direct current dynamos of all powers.

The Compagnie Industrielle of Liége exhibits two triphased current alternators. One of these is of 1,000 kilowatts at 2,200 volts, and makes 83·5 revolutions a minute. It has 72 poles and runs at a frequency of 50 periods a second. It is claimed that its industrial rendering reaches 94 per cent. when running at full speed. The second triphased current alternator has a power of 80 kilowatts at 530 volts, makes 600 revolutions a minute and has a frequency of 50 periods per second.

Again, we remark a Kolben triphased current alternator of a power of 825 kilowatts at 3,000 volts. The number of inductor poles is 64, the angular velocity is

94 revolutions a minute, and the frequency 50 periods a second.

Ganz & Company, of Budapest, whose name is already well known in the history of the development of alternating currents, have always been engaged in the construction of continuous current alternators and dynamos. In a separate group it exhibits a triphased current generator of 1,200 kilovolt-amperes at 2,200 volts. The fly wheel of the steam engine carries the inductors, 48 in number, and the stationary armature is of the lamellated core type. The angular velocity is 125 revolutions a minute and the frequency 50 periods a second. The maximum tension of the exciting current is 90 volts and the maximum intensity 200 amperes.

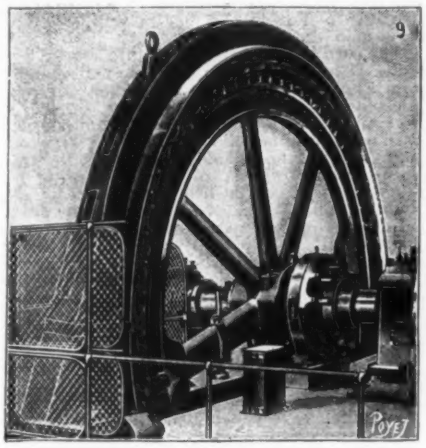
We shall not dwell upon the other types of triphased current alternators and continuous current dynamos that we find at this house's stand.

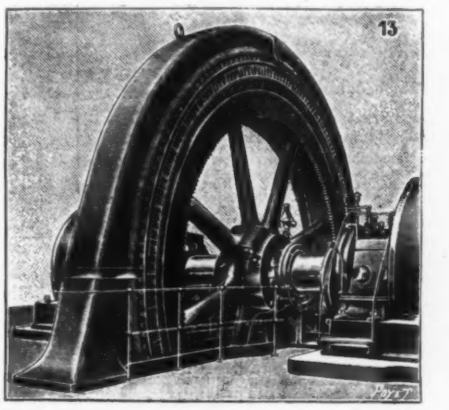
No eulogium of the Oerlikon establishment has any longer to be made, and it suffices to give the name of the builder of a machine coming from these works to show the value of it. We shall, however, mention a triphased current alternator of 1,300 kilovolt-amperes at 5,500 volts. This apparatus operates as a simple alternating current alternator at 2,200 volts, the windings of the armature being in parallel.

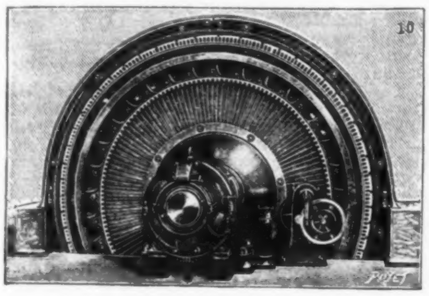
The Brown & Boverie establishment likewise exhibits triphased current alternators and a full line of dynamos of careful construction.

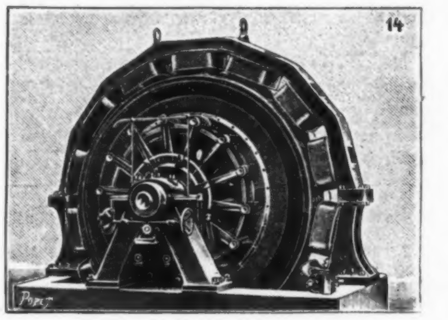
We may mention, too, the Alioth Works, the machines of which are employed in a large number of industrial applications.

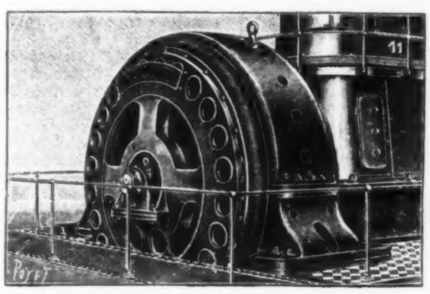
In this article we have been able to mention but very briefly the principal manufacturers of generators of electric energy without giving much information as to the construction thereof. We are, however, able to assert that at present the construction of electric machines has reached a high degree of perfection. They are to be had of all powers and of all differences of potential, giving simple and polyphased alternating currents at reduced angular velocities that often permit of a direct control by a steam engine; and all these machines offer most satisfactory industrial renderings.—La Nature.

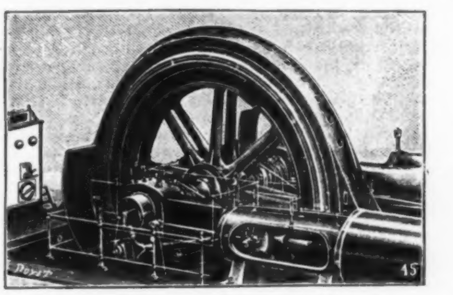


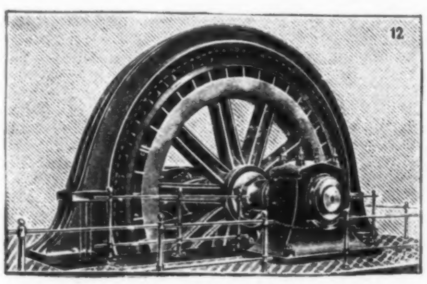


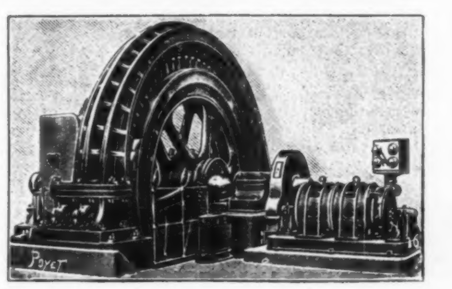


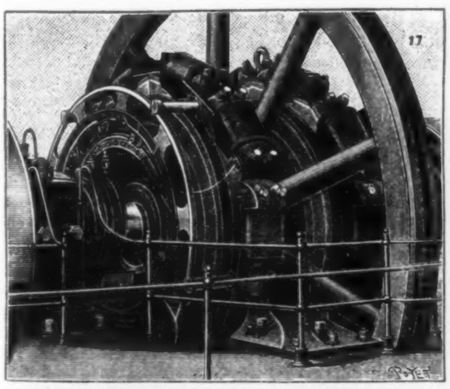


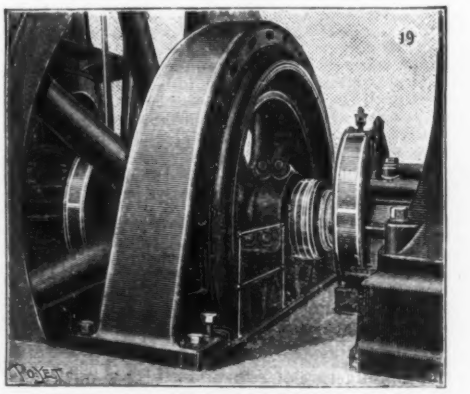


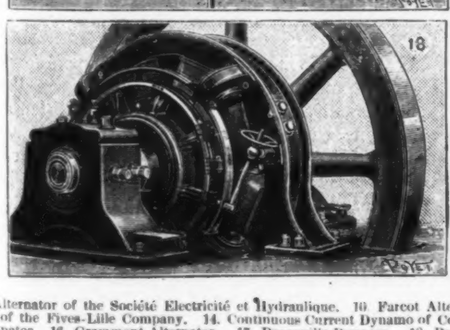












9. Alternator of the Société Electricité et Hydraulique. 10. Farcot Alternator. 11. Boucherot Alternator. 12. Labour Alternator. 13. Alternator of the Fives-Lille Company. 14. Continuous Current Dynamo of Compagnie Générale d'Electricité of Creil. 15. Schneider & Company Alternator. 16. Grammont Alternator. 17. Decauville Dynamo. 18. Postel-Vinay Dynamo. 19. Thomson-Houston Alternator. 20. Alternator of the Compagnie Générale of Nancy.

ELECTRIC MACHINES AT THE EXPOSITION OF 1900.

[Continued from SUPPLEMENT, No. 1295, page 20753.]

CHEMICAL AND TECHNICAL EDUCATION IN THE UNITED STATES.*

By Prof. C. F. CHANDLER, Ph.D., M.D., LL.D., D.Sc., Oxon.

INCANDESCENT MANTLES.

THE efficiency of gas lighting has been wonderfully increased by the introduction of the incandescent mantle invented by Auer von Welsbach. By the use of this beautiful device the light-giving power of gas has been increased enormously. Water gas which in the old-fashioned burners of the best kind yielded an illuminating power of five candles per foot of gas consumed, yields with the Welsbach mantle from 15 to 20 candle power, and with the improved mantles now being manufactured by the Welsbach Company at Gloucester, nearly 25 candles per cubic foot of gas consumed.

I had occasion recently to test one of the new mantles taken from the regular stock, and with a consumption of 5 feet of gas I obtained 122·5 candle power, or 24·5 candle power per foot of gas consumed. This great increase in the light produced by the incandescent mantle is due to Welsbach's latest discovery of the fact that the greatest amount of light can be obtained when the mantle consists of from 98 to 99 per cent. of thoria, which by itself emits little light, but has the advantage of making the toughest and most durable mantle, and from 1 to 2 per cent. of ceria, which in combination with the thoria exhibits the greatest light-giving power. The introduction of thoria and ceria into the affairs of everyday life is a very striking illustration of the advance of modern chemistry. In my student days ceria, and particularly thoria, were regarded as extremely rare earths, and I remember Prof. Woehler placed in my hands, in 1854, a few grammes of thorite from Sweden, from which I prepared thoria.

When Welsbach began his experiments upon thoria, it seemed impossible to procure anywhere in the world a sufficient supply of this material so as to make it available for use in the arts; but as soon as a demand was created, nature responded, and vast quantities of monazite, containing 5 or 6 per cent. of thoria, and much larger quantities of ceria, were discovered, first in the mountain streams of North Carolina, and later in the sea-shore sands of Brazil. There is every reason to suppose, therefore, that these and other localities will supply all the thoria that may be needed for the manufacture of these mantles.

I visited the works of the Welsbach Company recently, and my friend Waldron Shapleigh, the chemist of the company, who has worked up the methods for extracting chemically pure thoria from the monazite, showed me through the works. It was interesting to see streams of monazite running into the digesters in charges of half a ton each for the extraction of the thoria and ceria. I also saw hundreds of tons of the by-products, consisting of the salts of cerium, lanthanum, neodymium, and praseodymium, stored up in the hope that sooner or later some use will be found for them in the arts or in medicine.

The latest novelty in incandescent mantle lighting is the new Welsbach student lamp which burns gasoline of 74 degrees Baumé under a Welsbach mantle. The amount of light produced is incredible; it almost equals a moderate sized arc light. The lamps are made portable and stationary. It seems incredible that anyone should be willing to bring 74 degree gasoline into his dwelling house, but I am told that in the West this new lamp is meeting with great success. It is really astonishing how reckless people are with regard to the use of inflammable oils.

Gasoline cooking stoves, particularly for summer use in country houses, are meeting with considerable success.

ELECTRIC LIGHTING.

I cannot leave the subject of artificial illumination without saying a few words with regard to electric lighting, the development of which is largely due to the enterprise and inventive skill of American electricians. Although the arc light was exhibited by Sir Humphry Davy in the beginning of this century, and many devices had been invented for perfecting it, we attribute the practical development of the arc light for street lighting and for use in large buildings as an every

* Read at the nineteenth annual general meeting of the Society in London, in the theater of the Royal Institution, Albemarle Street, on Wednesday, July 18, 1900, Prof. C. F. Chandler, President of the Society, in the chair.

day agency to Charles M. Brush, of Cleveland, who, about 1871, perfected his system of arc lighting. We also feel warranted in the claim for Thomas A. Edison, our brilliant inventor, of the credit of first evolving the successful system of incandescent electric lighting, although we cheerfully give credit to your distinguished President-elect, Mr. Swan, for his independent inventions in the same field.

In 1877 I had the pleasure of spending two or three days with Mr. Edison and Prof. George F. Barker, of the University of Pennsylvania, in the laboratory of Mr. Wallace at Ansonia, Conn. Mr. Wallace had invented a new dynamo and a new system of arc lighting, and he invited us to Ansonia to see it in operation. Up to this time Mr. Edison had paid no attention whatever to the subject of electric lighting, having devoted himself to telegraphy, in which he had made most important inventions. He manifested the greatest interest in the subject of electric lighting, and at once turned his attention to the subject, and in 1878, less than one year, he had perfected his system of incandescent lighting, including the incandescent lamp, the regulator, safety switches, dynamos, and system of distribution, by which the amount of current supplied to each lamp could be properly regulated.

Although many incandescent lamps had been devised prior to this time, no one of them was practically successful. Edison's new departure consisted in using a high resistance carbon filament, hermetically sealed in a glass bulb, thus reducing the amount of current required for each lamp, by increasing the resistance of the carbon filament. Edison's great object was to secure a unit of light corresponding in intensity to an ordinary gas flame, particularly suitable to domestic lighting. In this he achieved a complete success, contrary to the general impression among electricians that it was impossible to divide the electric light into small units and impossible to successfully distribute the electric current to a large number of such units, even if they could be secured.

It is quite evident that we have not yet reached the limit of possibilities in connection with the economy of artificial illumination. At this moment there are two improvements in electric lighting which seem to promise a much larger amount of light for a given output of current.

In Edison's first lamps there was a consumption of 4·6 to 4·7 watts of energy per candle power. By a careful series of experiments he discovered means by which the required energy was reduced to about three watts per candle power. Beyond this it seems impossible to go with the carbon filament. But now come Auer von Welsbach, of Vienna, and Prof. Nernst, of Goettingen, each with a new improvement that will greatly increase the amount of light from a given amount of energy.

Welsbach substitutes osmium for carbon, and he has devised a method for producing an osmium filament by which from three to four times the amount of light is produced with the same amount of energy. The introduction of this new osmium incandescent lamp would treble or quadruple the capacity of incandescent light plants.

Nernst substitutes thoria for his incandescent material; a substance which though a poor conductor when cold is a sufficiently good conductor when hot, and Nernst has provided an ingenious device by which the thoria is raised by the current to the proper temperature for emitting light. Who can estimate the advantage to the world of an unlimited supply of cheap light?

ARC LIGHT CARBONS.

Incidentally I might remark that a great industry has grown up in the manufacture of carbons for the arc light, and for anodes for electro-chemical processes and electric furnaces. The magnitude of this industry is made apparent by the fact that we have a carbon company with a capital of $10,000,000 in the United States, and that a Canadian company with a capital of $2,000,000 has recently been organized. The carbon employed consists largely of the coke from the petroleum stills, the supply of gas carbon being entirely inadequate.

NATURAL GAS.

Our natural gas supplies continue to decline in quantity and pressure. Occasionally new territory is opened and supplies are obtained, but never in sufficient quantity to maintain the pressure. There is a gradual falling off in the yield, and it is evident that the supply of natural gas will be sooner or later practically exhausted. The value of the gas obtained in 1898 was $15,296,000, of which nearly $7,000,000 came from Pennsylvania, $5,000,000 from Indiana, $1,500,000 from Ohio, and one and a third million from West Virginia. New York supplied only $229,000 worth. Next in order came Kansas, Kentucky, California, Utah, Colorado, Illinois, and a few other States.

SUGAR REFINING.

Sugar refineries were established in the United States at an early day, and some of them have reached enormous magnitude, single refineries turning out two or three million pounds of refined sugar daily. In 1869 I visited Europe for the purpose of looking into the method there employed in sugar refining, and I was very much surprised to discover how favorably American methods compared at that time with those employed in Europe. Things are now more equal. This was notably the case in the treatment of the bone black and in the use of labor-saving machinery for handling the sugar, the bone black and the fuel.

The most marked contrast was noticeable in the kilns for reburning the bone black. While in America the greatest care was taken to protect the bone black while hot from contact with the air, I was surprised to find how little attention was paid to this point, particularly in the French refineries, where the bone black after being reburned was gray instead of black, the carbon having been burned out of the surface.

BEET SUGAR.

Great progress has been made in recent years in the beet sugar industry. Owing to improved processes of manufacture and to the information which has been secured by the investigations of the Agricultural Department with regard to soils and climates adapted to the sugar beet culture, it has become possible in various parts of the country to compete successfully with imported sugar and with the cane sugar cultivated in the Southern States.

THE BEET SUGAR FACTORIES OF THE UNITED STATES.

Name.	Location.	Daily Capacity.
In operation.		Tons.
Alameda Sugar Co.	Alvarado, Cal.	800
Western Beet Sugar Co.	Watsonville, Cal.	1,000
American Beet Sugar Co.	Chino, Cal.	1,000
Los Alamitos Sugar Co.	Los Alamitos, Cal.	700
California Beet Sugar and Refining Co.	Crockett, Cal.	1,200
Oregon Sugar Co.	La Grande, Ore.	350
Utah Sugar Co.	Lehi, Utah	350
Ogden Sugar Co.	Ogden, Utah	350
Pecos Valley Beet Sugar Co.	Carlsbad, N.M.	200
American Beet Sugar Co.	Grand Island, Neb.	350
American Beet Sugar Co.	Norfolk, Neb.	350
Minnesota Sugar Co.	St. Louis Park, Minn.	350
Michigan Sugar Co.	Bay City, Mich.	500
First New York Beet Sugar Co.	Rome, N.Y.	200
Binghamton Beet Sugar Co.	Binghamton, N.Y.	350
Spreckels Sugar Co.	Salinas, Cal.	3,000
American Beet Sugar Co.	Oxnard, Cal.	2,000
Union Sugar Co.	Santa Maria, Cal.	500
Illinois Sugar Refining Co.	Pekin, Ill.	700
Colorado Sugar Manufacturing Co.	Grand Junction, Colo.	350
Standard Beet Sugar Co.	Ames, Neb.	500
Bay City Sugar Co.	Bay City, Mich.	500
Detroit Sugar Co.	Rochester, Mich.	500
Wolverine Sugar Co.	Benton Harbor, Mich.	350
Peninsular Sugar Refining Co.	Caro, Mich.	600
West Bay City Sugar Co.	West Bay City, Mich.	500
Alma Sugar Co.	Alma, Mich.	600
Holland Sugar Co.	Holland, Mich.	350
Kalamazoo Sugar Co.	Kalamazoo, Mich.	500
D. C. Corbin	Waverly, Wash.	350
New: Building for the Campaign of 1900.		
American Beet Sugar Co.	Rocky Ford, Colo.	1,000
National Sugar Co.	Sugar City, Colo.	500
Continental Sugar Co.	Fremont, O.	350
Empire State Sugar Co.	Lyons, N.Y.	600
Marine Sugar Co.	Marine City, Mich.	350
	Total	22,250

During the season of 1892–93, 12,000 tons of beet sugar were produced. This quantity has rapidly increased until, during the season of 1899–1900, the product reached 90,000 tons. There are thirty factories now in full operation and five more are in process of construction. The daily capacity of these thirty-five factories will be 22,250 tons of beets.

Many of these factories use the process of Charles Steffen, in which the mother liquors are worked over and very little molasses is produced. Nearly all of these factories carry on refining processes, and turn out white granulated sugar ready for immediate consumption, which sells freely in competition with refined sugar from the cane. In some factories, where the conditions are most favorable, the beets yield as high as 18 per cent. of sugar, although the average is considerably below this figure.

Michigan factories obtain from 128 to 182 pounds refined sugar per ton of beets. The prices paid for beets vary from $4 to $4.75 per ton for beets of 12 per cent. of sucrose and 80 per cent. purity; and from 25 to 33⅓ cents per ton additional for each 1 per cent. of sucrose above 12 per cent.

The Louisiana crop of this year will be probably 400,000 tons; the annual consumption of sugar in the United States is about 2,000,000 tons.

CASEIN AND MILK SUGAR.

Casein and milk sugar are now manufactured on a considerable scale, the former from the skimmed milk from our creameries, the latter from the whey of our cheese factories. There are six factories engaged at present in making silk sugar, and the product is fully equal to any imported.

INDIAN CORN.

One of the most important raw materials which comes to the hands of the chemists in the United States is Indian corn, next to hay the largest product of our farms. Besides being employed as food in various forms for men and domestic animals, it is the material from which we manufacture a large proportion of our starch, most of our alcohol, and all of our grape sugar, and a new enterprise is now being inaugurated for the purpose of manufacturing from the stalks a peculiar form of pith cellulose, which is to be used in the construction of war vessels. This cellulose is obtained in the form of pressed cakes, which is to be used for packing what we call the cofferdam of vessels. A cofferdam is a double-skinned compartment. That is to say, a few feet inside of the main or outer skin of the ship there is a second skin, and between the two, extending above and below the water line, there is a belt of this cellulose, packed to a density of 6½ pounds to the cubic foot. The moment the outer shell of the vessel is pierced by a shell, the water swells the cellulose and closes the opening, so that no water can pass through. This cellulose is used by our government in its warships, and is rendered fireproof by saturating it with a chemical compound, which renders it non-inflammable. Many other applications have been proposed for this substance.

STARCH AND GRAPE SUGAR.

For the manufacture of starch and grape sugar the raw corn, which costs about twenty cents a bushel of fifty-six pounds, is soaked in water for about thirty hours. A little sulphurous acid is added to the water to prevent fermentation and putrefaction. After the corn has been soaked, it is passed between burr-stones and coarsely ground. It is then passed through three successive machines called beaters, which consist of cylinders with arms revolving with great rapidity, in order to beat the cracked corn, and loosen the starch. Having been properly beaten, it is then passed through a squeezer, which thus extracts the water and starch, which passes through an endless wire gauze, leaving behind the hulls and germs of the corn. The starch is then carried on, suspended in water, and being properly sifted to take out the coarser particles is run upon tables, like bowling alleys, 100 feet in length. As the milky fluid moves along the tables, the starch settles, and the water passes on. After a time the starch becomes so solid that it can be shoveled up in lumps, and it is subsequently dried and is known as cornstarch. It is generally subjected to the action of a weak solution of caustic soda for the purpose of freeing it as much as possible from proteid substances. The hulls and germs are mixed with a combination of starch and water of such a gravity that the germs float, while the hulls sink to the bottom. The germs are drawn off from the top and separated by a sieve and the hulls are drawn off from the bottom and separated in the same manner.

The corn is thus subdivided into starch, germs, and hulls. The germs are dried, and in this condition contain 53 per cent. of corn oil. They are ground and pressed, and yield about 40 per cent. of oil. The cake which is left behind, and which contains about one-fifth of the original oil of corn and a large percentage of proteid matters, is sold for cattle food. The original corn contains from six to seven per cent. of oil.

As about 200,000 bushels of corn are treated daily, and about five per cent. of oil is obtained from it, corn oil has become an important article of commerce. A portion of it is employed in manufacturing a substitute or addition for India rubber. A great deal of the oil is shipped to Europe, but is never heard of again as corn oil. It brings about 21 cents a gallon in the market. I might say that the whole profit of the starch and grape sugar business is more than represented by the value of the oil obtained.

The hulls are dried and ground to powder, and the water in which the corn has been steeped is boiled down to a thick gruel and added to the ground hulls, giving them a very delightful flavor which the cattle highly appreciate. It sells for about $6 a ton, while the cake from the germ sells for about $9 a ton. A bushel of corn yields thirty pounds of starch and sixteen pounds of feed.

The starch is used for laundry purposes and in calico print works, and some of it is converted into dextrine for our postage and revenue stamps.

The grape sugar industry has reached enormous proportions. Various acids have been used for converting the starch, sulphuric acid, oxalic acid, and hydrochloric acid. The conversion takes place under pressure. Water and a certain quantity of acid are first introduced into the converters and raised to the proper converting temperature. The starch suspended in cold water is pumped into the boiling acid. As the conversion goes on during the pumping, there is never any accumulation of starch paste in the converters. The extent to which the conversion is carried depends upon the purpose for which the product is designed. If the product is to be sent to market in solid crystalline form the conversion is carried to completion, and the product is sold as "grape sugar." If, on the other hand, the product is to be sent to market in liquid condition, when it is sold under the name of "glucose," the conversion is not carried so far, and it is found in practice that in order to prevent the solidification of the liquid glucose, it is necessary to leave a certain percentage of dextrine unconverted. The products are dextrine, maltose, and dextrose. The first two diminish in quantity the longer the boiling is continued. It takes from 12 to 15 minutes to pump a charge of starch into the converter, the capacity of which is usually about 1,000 gallons, and it takes a little longer than this to complete the conversion, the maximum temperature being about 270° Fah. The product is run out into vats, neutralized with carbonate of lime if sulphuric acid or oxalic acid is used; with carbonate of soda when hydrochloric acid is used. It is then passed through the filter-press, and bone-black filter, and concentrated to about 30° Baumé, when it is again passed through the bone-black and then further concentrated. The glucose is then ready for the market, while the grape sugar must now be crystallized. For this purpose there is added to the fluid a quantity of what is called "induction," which is previously crystallized anhydrous dextrose. This is thoroughly incorporated with the fluid, which is then placed in small crystallizing troughs, in which it solidifies in a few hours to a beautiful crystalline mass. The anhydrous crystals of glucose serve as the nuclei for the crystallization. The product very much resembles ordinary sugar. Some of it is colored by the previous addition of a little caramel. It averages about 80 per cent. of anhydrous dextrose. This sugar finds a large application among the brewers as a substitute for malt, among the molasses manufacturers for brightening the color of the molasses from cane and beet sugar, among the confectioners, and in various other industries. The importance of the industry can be inferred from the fact that there is a glucose trust with a capital of more than $40,000,000.

When this sugar was first put upon the market, it was alleged to be unwholesome, and the Treasury Department at Washington referred the subject to the National Academy of Sciences for investigation. A committee of chemists was appointed to make a careful investigation of the industry and its products, and they reported that nothing objectionable was used in the manufacture, that no objectionable substance was developed in the process, and that there was nothing objectionable or unwholesome in the product.

The corn crop of 1899 amounted to 2,078,000,000 bushels, and of this 35,000,000 bushels are consumed by the grape sugar manufacturers. The land devoted to this Indian corn cultivation is 82,108,000 acres; the average yield being 25·3 bushels per acre.

There are three grape sugar factories in Illinois, and two in Iowa.

In addition to cornstarch, we also manufacture considerable quantities of wheat and potato starch. In the State of Wisconsin alone over 300,000 bushels of potatoes are used in the starch factories.

(To be continued.)

INFECTION AND POSTAGE STAMPS.

THE brothers of the Saint Jean-de-Dieu Hospital at Ghent, Belgium, "who would seem," says The British Medical Journal, "to have a good deal of leisure time on their hands," have hit on a novel style of wall decoration. They have papered the parlor, the two refectories, the twenty-eight rooms, and all the corridors of that establishment with stamps, ingeniously arranged in such a fashion as to represent palaces, forests, rivers, flowers, insects, and even persons, the latter in life size. "All the subjects," says The Journal, "are treated in the Japanese style with remarkable perfection. Many of the Belgian painters have been to see these highly original works of art, in the execution of which some twenty millions of postage stamps have

been employed. We are willing to believe that the artistic effect of this new style of mural decoration is admirable; but from the sanitary point of view—which after all should not be altogether lost sight of in the decorations of a building intended for the reception of the sick—we are disposed to think it a little questionable. A severe hygiene would doubtless proscribe any kind or description of wall paper as being likely to harbor the ubiquitous microbe. With regard to postage stamps in particular, cause has recently been shown to regard them with special suspicion as possible agents in the dissemination of tuberculosis infection. A French investigator has shown that the stamps are often infected by means of the saliva of diseased persons, and he has uttered a note of warning to this effect to stamp collectors. He had occasion to observe a man suffering from tuberculosis who plied a trade in stamps, and who was in the habit of sticking them on gummed paper after moistening them with his tongue. A number of stamps which had been thus dealt with were placed in sterilized water. The water was afterward inoculated in some guinea pigs, all of which died with well-marked signs of tuberculosis. Against so subtle an enemy as tuberculosis, no precaution can safely be neglected. The moral of the experiments to which we have referred is that postage stamps are not to be recommended either as hobbies or as mural decorations except under antiseptic precautions."

POISONOUS SNAKES AND SNAKE POISON.*

By GUSTAV LANGMANN, M.D., of the Department of Pathology, College of Physicians and Surgeons, Columbia University, New York.

THE zoological order Ophidia is popularly divided into non-poisonous, or harmless, and poisonous snakes. Such division appears quite natural, yet it is neither practical nor is it based on anatomy or biology; for in practice it is impossible to distinguish an innocent snake from a similar poisonous one by easily recognized characteristics. Harmless and some poisonous snakes have certain anatomical features in common.†

Snakes are provided with two rows of palatal teeth besides the usual marginal teeth of the upper and lower jaws; both run almost parallel. The teeth, solid pointed hooks, are curved backward; they are used for hooking the prey rather than for purposes of attack or defense. When the very dilatable mouth is repeatedly opened, the teeth are at the same time thrown forward so that the prey is gradually dragged down into the widely distensible œsophagus. In the innocent snakes the teeth in both jaws extend back almost to the commissure of the mouth; in the poisonous snakes, however, the strength of the whole row of marginal teeth of the upper jaw is, as it were, concentrated into one powerful tooth, the poison fang, which projects at the distal end of the maxilla. It is true, you will often find two or three teeth at this point; these are succedaneous teeth, which fix themselves into place when the snake has broken the main fang or lost it while shedding its skin. Such a fang is, as a rule, replaced by a new one about every six weeks; the old one is loosened by odontoclasts in Howship's lacunæ, just as are the milk teeth of an infant.‡ The fangs are firmly inserted, standing immovable in one family of the venomous snakes, the Colubridæ venenosæ, to which the cobras and hydrophids belong; in the other, the Viperidæ, including the true vipers and pit-vipers, they are erected for biting and are folded like a pocket-knife when at rest. This mechanism works in this way: the pterygoid muscles act on the shortened and vertically situated maxilla in which the fang is firmly fixed.

Another division is sometimes made by classifying the snakes according as they have short, cone-shaped, furrowed fangs, or are provided with long, pointed, tubular ones. This condition is brought about developmentally in the first instance by the folding of the dentine, which leaves a longitudinal furrow along the anterior surface; and in the second by a complete approximation, which produces a perfect tube. To the first class, the Proteroglypha, belong the Hydrophids and Elapidæ, or cobras; the latter class, the Solenoglypha, comprises the vipers and pit-vipers. The intensity of a poisonous bite is not dependent upon the shape of the fangs, except that a longer tooth, such as that of the viperine snakes, is capable of injecting the poison to a greater depth; indeed, the viperine poison apparatus is the most perfect of any in the venomous snakes.

We have to consider a third class of poisonous serpents, the so-called Opisthoglypha, the furrowed fangs of which, as the name indicates, are situated toward the rear of the mouth. There has long been a doubt as to whether they should be classed among the poisoners, and for this reason they were grouped together under the name of "suspecti." Recent investigations, however, have proved to a certainty that they also poison their prey, which mostly consists of small, cold-blooded animals. Catching them first with the innocuous front teeth, they push them gradually backward into the reach of the poison in the back teeth, to the action of which they soon succumb.

The poison apparatus is completed by the addition of the poison gland, which is closely in contact with either side of the skull, directly behind the eye, and is under the influence of the overlying masseter muscle. In some small East India snakes, Callophis, the elongated glands extend into the abdomen, so that they are emptied by a vigorous contraction of the muscles of the whole body. The efferent duct of the gland does not lead directly into the hollow of the fang; if it were so, every shedding of a fang would necessitate the formation of a new duct; the glandular secretion flows into a groove of the mucous membrane, which adapts itself directly to the base of the fang.

Let us now consider the poison apparatus. The poison glands, button, tube, or almond shaped, with anterior elongated duct, are situated behind either eye, and when extraordinarily developed, as in the Crotalids, give to the head that triangular shape which was erroneously considered the characteristic of all poisonous snakes, and which gave to some species the name Trigonocephalus. The glands are the homologues of the common parotid; of the latter it is also well known that it alone produces an albuminous secretion. As to structure, they belong to the compound racemose glands with elongated acini; the glandular substance has columnar, the duct pavement epithelium. They respond to the action of belladonna exactly like any parotid gland.

A slight thickening of the duct is caused by a circular constrictor muscle, so that the snake is able to retain its secretion at will; and indeed it may be thus retained and not used for months. While the mouth opens, nothing flows out, and only when the masseters in closing the jaw compress the glands, a fine stream squirts out of the pointed teeth. The secretion of the other salivary glands and of the mouth is alkaline, while the poison is always acid. The color of the latter varies from a straw or greenish-yellow to a deep orange. The viscous fluid, either clear or turbid (bitter in Naja), is not odorless, as often asserted; it has a specific smell for every species, which is not easy to describe, but easy to recognize, thus the odor of crotalus poison may be called "mousy"; its specific gravity varies from 1·030 to 1·077; the solids are variously stated as from twelve to sixty-seven per cent.; my own samples are mostly dried down to twenty-five or twenty per cent. of the original weight. The dry poison cracks in scaly translucent chips of a light yellow or deep brown color, and also has a characteristic odor. Fresh poison under the microscope shows nothing but a few scaly epithelia and a number of finely granulated, amorphous, albuminoid masses, which undergo no change in a hanging drop, even after a long while.* It was often and even is to-day asserted that bacteria or cocci exist in the poison. To establish this positively, I sterilized my collecting apparatus thoroughly, and not the least sign of bacterial life was seen in broth or gelatin cultures of the fresh poison; also in acid media in which the experiments were repeated, no trace of life was to be found. In order to determine whether the poison which itself destroys life might for that reason be free from microbes, I mixed fresh poison with bacillus subtilis and bacterium coli for one-half hour and then inoculated it on gelatin. The growth was lively, even more lively than in the control plates, probably because the gelatin was liquefied at the points of contact with the poison.† A bacterial action, therefore, cannot be assumed; the rapidity alone with which the poison acts in the system would exclude bacterial influence. What, then, is its active constituent? The first chemical analysis was made in 1843 by Prince Lucien Bonaparte, who established the albuminous nature of viper poison and called the poison "viperin." Almost twenty years later, 1861, Weir Mitchell found a similar proteid in crotalus poison, which he named "crotalin." Other investigators claimed to have found alkaloids or ptomains, when Weir Mitchell again, in conjunction with Reichert, published, in 1883, the results of their studies, that the active principle of snake poison was an albuminoid, but instead of one they had discovered two. One of them, easily dialyzable and coagulable by heat, was called venom-peptone; the other, not dialyzable and not coagulable by heat, venom-globulin. The proportions of both were not alike in cobra and crotalus poison; even among the Crotalidæ they found wide differences. Thus cobra poison had ninety-eight per cent. of peptone and two per cent. of globulin, but moccasin venom had ninety-two per cent. of peptone and eight per cent. of globulin, diamond-back only seventy-five per cent. of peptone and twenty-five per cent. of globulin. Besides the proteid, there are a coloring substance, several salts, and some fat. Mitchell's report was mainly corroborated in 1886 by Wolfenden in England, who discovered globulin and several albumins in variable proportion in the poison of cobra and daboja: one of the latter he designated serum-albumin; the other, corresponding to Mitchell's peptone, syntonin or albumose. Kanthack's analyses likewise demonstrated the presence of a proto and hetero-albumose in cobra poison. Martin and McGarvey Smith found also a harmless albumin and two very toxic albumoses in the poison of the Australian snakes. It may be asserted that in no instance has a definitive analysis of any poison been worked out to this day, but all investigations center in this one fact, that the active principle in all snake poisons is some form of albumose.‡

In default of accurate analyses, I will use the convenient terms, venom peptone and globulin, in our further discussion. Not only do the various poisons differ in the percentages of peptone and globulin, but also in the toxicity of the constituents themselves.‖ The venoms retain their efficacy for long periods of time under suitable conditions; poison, when dried or mixed with glycerin, has proved itself as active as fresh poison, even after a lapse of twenty-two and twenty years respectively. Freezing continued through weeks does not alter it; putrefaction destroys it after a long time, but it is soon changed by heating when the temperature is raised to different heights, according to the different chemical composition. The easier coagulable globulins are rendered innocuous at 80° C., while the peptones are destroyed only by applying heat for hours. The coagulated proteids are inert in this condition, but they regain their toxicity when redissolved. It is the more or less evident capability of chemicals to coagulate proteids which determines their relative power of destroying the efficacy of venoms, when they are mixed with the poison in a test tube for experimental purposes. Alcohol renders it inert for a time only. Absolute alcohol seems to coagulate all poisonous ingredients, but the presence of an infinitesimal part of water is sufficient to retain the toxicity of the supernatant fluid. Poisonous serpents, when preserved in alcohol, have to be handled, even after years, with the greatest care, as has been demonstrated by a fatal accident to an assistant in the St. Petersburg Museum.

The physiological effects of both ingredients named, whenever they are tested separately in animals, are widely different. The peptone, though causing some local œdema, is more productive of general symptoms, which commencing as irritation, twitching, and convulsions, finally end in paralysis; paralysis of the respiratory center is especially characteristic. The globulin, on the contrary, incites a violent local reaction with hemorrhages around the point of injection, hemorrhages of the mucous membranes, and destruction of the coagulability of the blood. The latter phenomenon recalls to us the results of experiments performed on animals with pure peptones and albumoses of digestion. Kühne, Pollitzer, Schmidt-Mülheim, Shore, and Matthes found in a large number of these experiments not only characteristic hemorrhages and necroses, but also paralyses, the intensity of which was in correspondence with the higher hydrolysis of the albumoses.

Leaving aside the cases of almost instantaneous death which are due to general thrombosis, especially when the venom has been accidentally injected into a large blood vessel, we usually see about the following symptomatology. We will consider first the less complicated picture of the effects of a cobra bite: two small, scarcely visible punctures in the skin are found, whence radiates a burning and stinging pain with gradually extending œdema. Within an hour, on an average, the first constitutional symptoms appear—a pronounced vertigo, like that of drunkenness, quickly followed by weakness of the legs, which is increased to paraplegia, ptosis, falling of the lower jaw with paralysis of the tongue and epiglottis, inability to speak and swallow, with fully preserved sensorium. A mass of viscous, frothy saliva is constantly dribbling from the open mouth; nausea and vomiting set in; the paralysis becomes general, the patient lies motionless. The pulse, a little accelerated, is somewhat weaker in the beginning, but keeps a moderate strength until even a few minutes after the cessation of respiration. The latter, also accelerated in the beginning, soon becomes slower, labored, and more and more superficial, until it dies out almost imperceptibly. The pupils, somewhat contracted, react up to the last moment. Slight convulsions, which we are accustomed to see in asphyxia, sometimes occur shortly before death. Absorption is exceedingly rapid; already after thirty seconds a distinct areola is visible around the bite. Death occurs at the latest within fifteen hours, in thirty-two per cent. in the first three hours. When the patients do not die of paralysis, they recover remarkably quickly and without later consequences. The autopsy reveals no changes in the skin at the point of injection; the subcutaneous tissue, however, is thickly infiltrated with reddish serum; the surrounding blood vessels are congested. All the internal organs are hyperæmic, and the bronchi are filled with frothy mucus and perhaps with fluids which have been forced into the patient's throat. The blood is mostly liquid and dark.

After the bite of a rattlesnake the local disturbance is most pronounced: violent pains at the bleeding wound, hemorrhagic discoloration of its surroundings, and later also of more distant parts; bloody exudations on all the mucous membranes, nose, mouth, conjunctiva, and hæmaturia, or rather hæmoglobinuria. Usually somewhat later than after cobra poisoning, but possibly within fifteen minutes, constitutional symptoms may develop, great prostration with nausea and vomiting. A continuous fall of blood pressure is noticed. Respiration, in the beginning accelerated, grows slow and stertorous. After a temporary increase of reflexes, which in susceptible animals and after large doses may rise to convulsions, opisthotonos, and tetanus, paresis supervenes, with paraplegia of the lower extremities, which progresses in an upward direction, ending in complete paralysis. Albuminuria appears after about six hours. In such a condition death may come inside of twelve hours. If the patient recovers from the paralysis, a septic fever may develop in consequence of the enormous and multiple hemorrhages, to which he may succumb after a lapse of time. Eventual recovery sets in very suddenly, even in the most desperate cases. Not rarely, however, suppurating wounds remain, which granulate poorly, break open repeatedly, and may lead later on to deep necrosis, even of the bones.* The autopsy shows a deep bloody infiltration at the bite, down into the necrotic muscles, hemorrhages of distant muscles, particularly of the intercostals; all serous membranes, chiefly the endocardium and the peritoneum, are completely covered by ecchymoses of all sizes; the lungs show subpleural ecchymoses and infractions; the kidneys are hemorrhagic in the glomeruli and pelvis, and there is cloudy swelling of the epithelium of the canaliculi. Hemorrhages have been observed also in the serosa and in the substance of the central nervous system. The blood is fluid, and does not clot, even after a long time.

(To be continued.)

Cement for Porcelain and Glass.—Mix 300 c. cm. of water with 300 c. cm. of lamp alcohol and stir in 60 grammes of starch and 100 grammes of whiting. Then add 30 grammes of good soaked glue and boil up the mixture once over an open fire. At the moment of boiling add 30 grammes of oil of turpentine and stir well, so that the various ingredients mix uniformly. For use, the mass is heated, and applied on the fractured edges, which are likewise warmed.—Photographische Mittheilungen.

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* Abstract of paper read before the Academy of Medicine, New York, and published in The Medical Record.

† A fact which is indicated by the usual division of snakes into Colubridæ, comprising all harmless snakes, Colubridæ venenosæ and Viperidæ.

‡ Kathariner: Wurzburg. Sitzungsber., 1896.

* It may be of interest to describe my method of collecting poison. It ought to be said in advance that poisonous snakes, as a rule—at least those of our country—are of a timid and retiring, rather than of an aggressive disposition. They are taken out of their cage with a curved stick on which they remain hanging, afraid to fall. Then they are laid upon a table or upon the floor, and, while they are stretching out to crawl away, their head is tightly pinned down to the table with the stick. The index finger and thumb thereupon grasp the neck of the snake behind its head so firmly that it cannot be turned. A funnel over which a chamois skin or thin rubber is tightly drawn is held in front of the snake, which throws both of its fangs through the cover of the funnel; the poison drops out of the fangs into the funnel and into a glass beneath the latter. While the snake is holding on, its glands may be compressed to squeeze out the last drop. The liquid poison is either mixed with equal parts of glycerin or it is dried under a bell-glass with sulphuric acid or calcium chloride.

† Experiments carried out by Dr. A. V. Moschcowitz with sterile snake poison have demonstrated that it liquefies gelatin like some digestive ferments, e.g., trypsin. Wehrmann (Annales Pasteur, 1898) finds that it peptonizes fibrin weakly and does not saccharify amylum.

‡ It is well known that albumoses, the products of the hydration of albumin formerly called propeptones and accurately defined by Kuhne and Chittenden in 1884, differ widely as to their toxicity. While our modern means do not allow yet a chemical differentiation of those albumoses generated by superheated steam, by gastric digestion, by bacilli or—as in our case—by the parenchyma-cell of a gland, the varying reaction of the more sensitive living organism toward them demonstrates decisively their different natures.

‖ Gastric digestion does not influence snake poison; the action of the bile, however, and of the pancreatic juice destroys it.

* It is remarkable that in some cases a periodical relapse of inflammation and suppuration of the old cicatrices is reported almost at the same time every year. Leon Stejneger, in The Poisonous Snakes of North America, p. 358, relates the case of the draughtsman of the Smithsonian Institution. After a bite of a coral snake, swelling and inflammation of a finger with loss of the nail are said to have recurred in ten successive years almost to the date of the bite. A cure was finally effected by means of the herb Micania guacho.

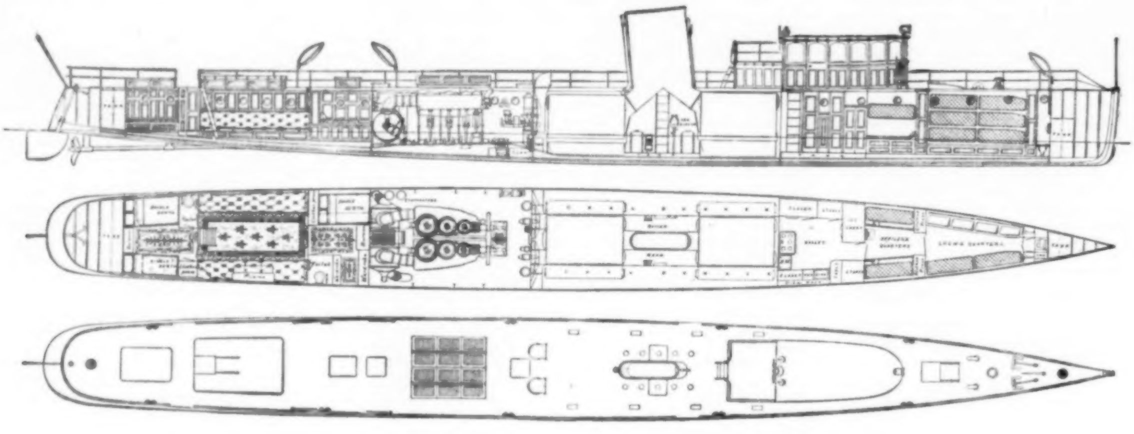
THE TWIN-SCREW STEAM YACHT "ARROW."

THE twin-screw steam yacht "Arrow," designed by Mr. Charles D. Mosher, of New York, for Mr. Charles R. Flint, also of this city, is undoubtedly the most notable recent example of a boat intended to attain the highest possible speed by the use of the most advanced and refined features of engineering practice. Particular interest attaches both to the design and construction of the hull and machinery, particularly on account of the remarkable speeds already attained of 40 knots an hour, the accommodations will in no sense be limited by the machinery necessary to propel the craft at this unprecedented speed, there being sleeping accommodations for no less than twenty-five persons. The furnishings will be luxurious, and she will be handsome enough to please the most critical.

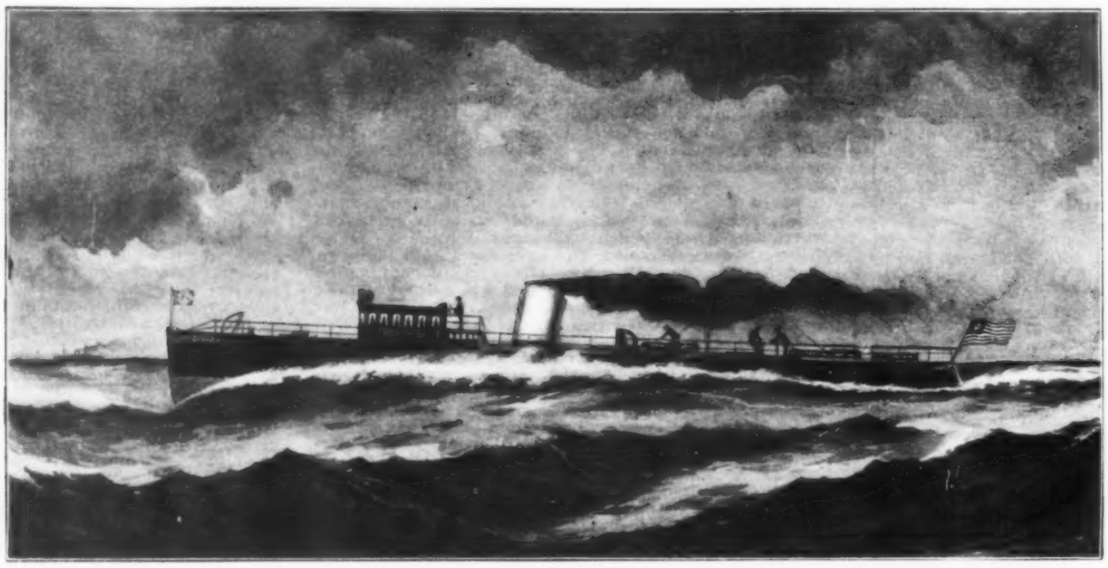
We present herewith two cuts of the yacht as she will appear when running at a high speed, and also when transformed into a torpedo-boat—a change which can be made in two hours. We also show sectional views of the yacht as well as of the engines and boilers.

bulkheads, dividing the hull into seven compartments as follows: Eight feet abaft the bow is a collision bulkhead, the compartment forward being used as a trimming tank and providing a large storage reservoir for fresh water. As shown in the plans, the crew's quarters are situated next abaft the collision bulkhead and extend the full width of the vessel for 15 feet of its length. Ample accommodations and folding berths, lockers, toilet, etc., are provided for twelve men.

Next to the crew space are located the officers' quarters, consisting of a double stateroom, which is also

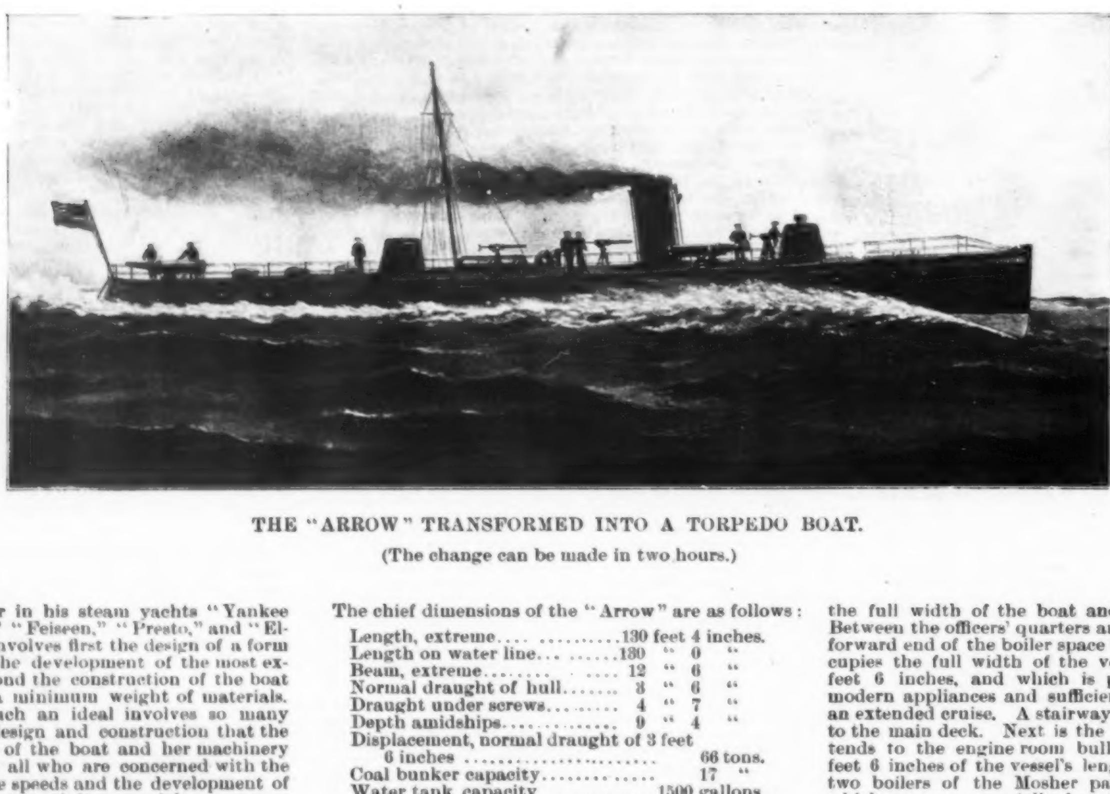


SHEER PLAN AND DECK PLANS OF THE "ARROW."



THE HIGH-SPEED STEAM YACHT "ARROW."

Length, 130 feet 4 inches; beam, 12 feet 6 inches; normal draught, 3 feet 6 inches; draught under screws, 4 feet 7 inches; displacement, 66 tons; horse power, 4,000; speed (estimated), 40 knots.



THE "ARROW" TRANSFORMED INTO A TORPEDO BOAT.

(The change can be made in two hours.)

by the same designer in his steam yachts "Yankee Doodle," "Norwood," "Feiseen," "Presto," and "Ellide." The problem involves first the design of a form of boat suitable for the development of the most extreme speeds, and second the construction of the boat and machinery with a minimum weight of materials. The realization of such an ideal involves so many special problems of design and construction that the following description of the boat and her machinery will be of interest to all who are concerned with the attainment of extreme speeds and the development of a maximum of power on a minimum weight.

Although the "Arrow" is designed to attain a speed

The chief dimensions of the "Arrow" are as follows:

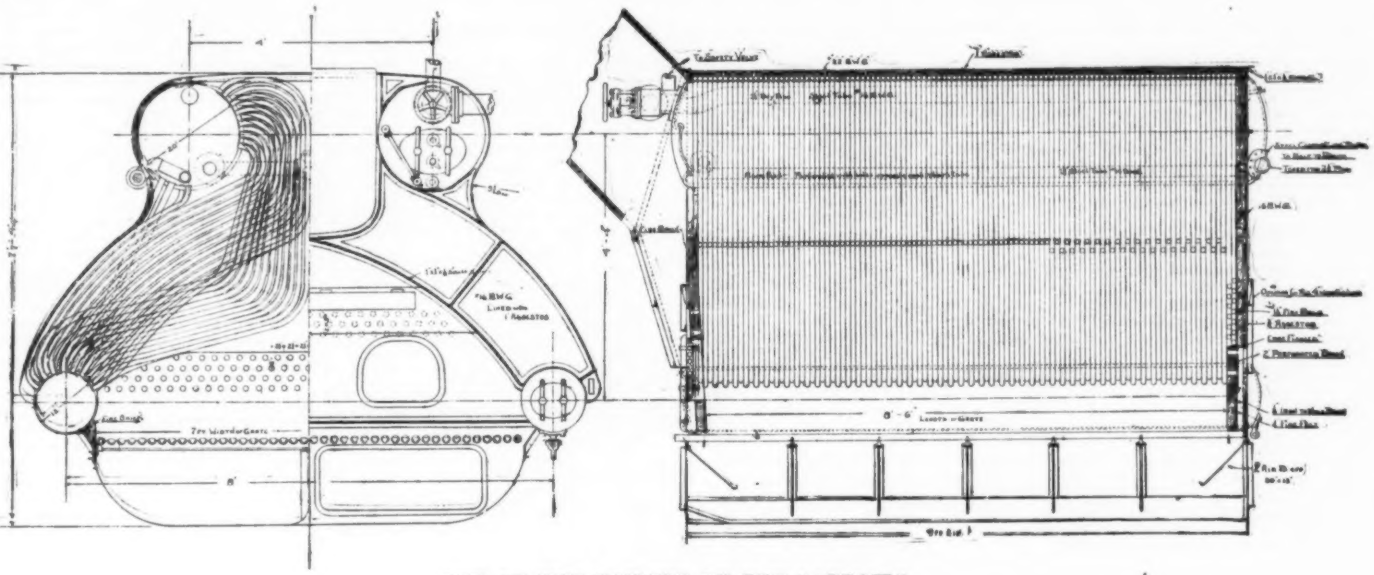
Length, extreme	130 feet 4 inches.
Length on water line	130 " 0 "
Beam, extreme	12 " 6 "
Normal draught of hull	3 " 6 "
Draught under screws	4 " 7 "
Depth amidships	9 " 4 "
Displacement, normal draught of 3 feet 6 inches	66 tons.
Coal bunker capacity	17 "
Water tank capacity	1500 gallons.

The boat is fitted with six transverse water-tight

the full width of the boat and 7 feet 6 inches long. Between the officers' quarters and the bulkhead at the forward end of the boiler space is the galley, which occupies the full width of the vessel for a length of 10 feet 6 inches, and which is provided with all the modern appliances and sufficient space for stores for an extended cruise. A stairway leads from the galley to the main deck. Next is the boiler room, which extends to the engine room bulkhead and occupies 30 feet 6 inches of the vessel's length. In this space are two boilers of the Mosher patent water tube type, which are more especially described at another point. Alongside of the boilers are the coal bunkers, which

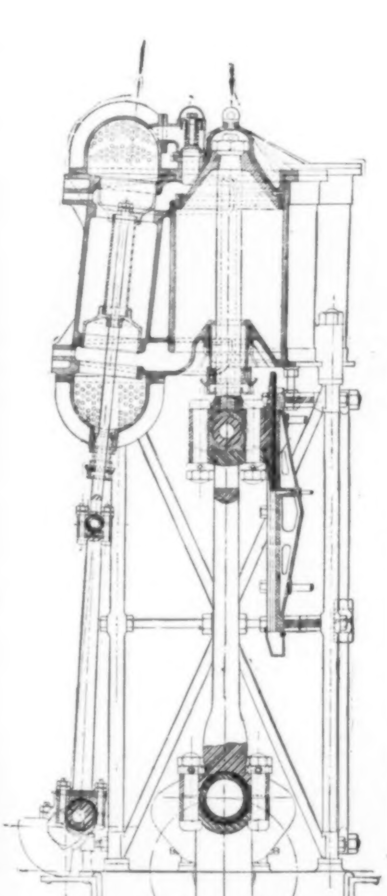
extend nearly the entire length of the boiler space and have a capacity of about 17 tons; while additional coal storage space will provide for a total capacity of about 30 tons, or a sufficient amount to enable the vessel to cruise upward of 3,000 miles. Aft of the boiler space is the engine room, containing two of the Mosher patent quadruple-expansion engines, which present a number of special features, referred to more particularly hereafter. Immediately aft of the engine room is the owner's stateroom, which occupies the full width of the ship and is 7 feet 6 inches long. This room will be handsomely fitted up and will contain a large berth, chiffonier, clothes press, two wardrobes, the ceiling of Hungarian ash. The saloon is lighted by eight large port lights, besides being lighted and ventilated by a monitor top through which leads the companionway. Aft of the saloon is a double stateroom finished in Hungarian ash. A toilet room is arranged to open conveniently from both the saloon and stateroom. Aft of the stateroom is the after collision bulkhead, and aft of this is a fresh water tank holding 300 gallons, and also a storeroom of 360 cubic feet capacity.

It will be noticed that the deck is particularly roomy, being clear of the usual houses. The pilot house, the only deck house carried, is 15 feet long and is are also of steel. The sides are double planked with mahogany brought to a smooth fair surface and highly finished. The deck is of wood except over the boiler space, where aluminum is used. The deck beams are aluminium bulb angles. Aluminium is used for many other details such as side and deck stringers, hatch framing, hatch covers, breast hooks, etc. The outer keel, stem and stern posts, flooring, pilot house, joiner work and other like features are of selected woods to best meet their respective purposes. Between the frames and sheathing on the sides and bottom, as well as between the deck plating and beams, a system of diagonal strappings is fitted consisting of thin

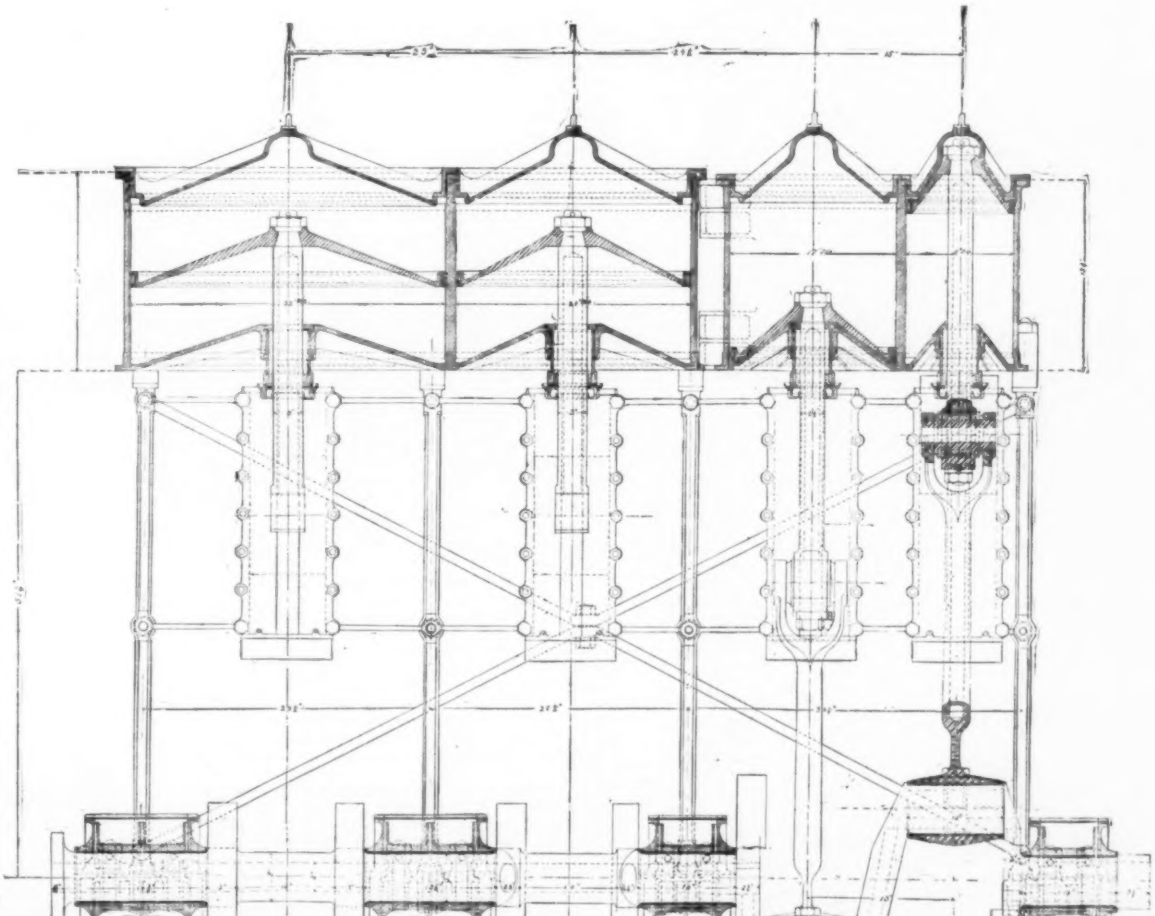


ONE OF THE BOILERS OF THE "ARROW."

Grate surface, 120 square feet; heating surface, 5,540 square feet; pressure, 444 pounds per square inch; weight, empty, 6·43 tons.



CROSS-SECTION THROUGH HIGH PRESSURE CYLINDER.



LONGITUDINAL SECTION THROUGH ONE OF THE TWIN ENGINES OF THE "ARROW."

Maximum horse power of the two engines, 4,000.

private bath, toilet, etc., the joiner work being of satinwood. It will be lighted by monitor top and four large port lights, and at night by a number of incandescent lamps. Next aft is the saloon, which is 13 feet 6 inches long and occupies the full width of the boat. It is to be most luxuriously fitted up and will contain a piano, library, an octagon buffet in each after corner, and gun racks, etc., for a full sporting outfit. The saloon is arranged to be converted into four staterooms by hanging draperies, and is lighted by numerous clusters of incandescent lamps of variegated colors. The joiner work is to be of English oak and ranged to be used as a dining room. The after portion is divided off and arranged as a pantry and is provided with silver and china closets and is also fitted with a dumb-waiter which connects with the galley below. It is also connected with a storeroom under the bridge.

Aft of the pilot house is the bridge. The general construction of the boat is composite in character. The frames are steel below the water line and aluminium above, except through the boiler and engine spaces, where they are of steel throughout. The keelson, all floor plates, reverse frames, bunker bulkheads, boiler saddles, engine foundations and many other details steel plates about 8 inches in width, tapering at ends. This diagonal bracing or strapping is built in under tension and is intended to tie the boat together longitudinally, and provide the necessary transverse and torsional strength and stiffness.

Two small boats will be carried, a 15-foot cutter and a 13-foot dinghy. The yacht is to be fitted with quite an extensive electric plant capable of supplying sixty incandescent lights and a powerful search light, and is also provided with two powerful blowers for ventilation and supplying forced draught for the boilers, surface condensers with circulating pump with special engines

for same, bilge pumps, and six powerful ejectors, having a combined capacity of over one hundred tons of water per hour.

Turning now to the boilers, we have the following principal items:

Type.—Mosher patent curved water tube.

Number.—2.

Grate surface.—120 square feet.

Heating surface.—5,540 square feet.

Pressure allowed by United States Steamboat Inspection.—444 pounds per square inch.

Weight of two boilers, empty.—12·86 tons.

Weight of two boilers in steaming condition.—15·59 tons.

Weight per square foot of heating surface without water.—5·2 pounds.

Weight per square foot of heating surface with water.—6·3 pounds.

The usual full working pressure is intended to be about 400 to 440 pounds at the boilers and 350 pounds to 400 pounds at the engines. In the boiler space are two specially designed blowers, two independent duplex feed pumps, two feed water regulators, and a hydraulic ash ejector, besides the usual gages and fittings.

Passing now to the propelling engines, we have the following chief particulars:

Type.—Mosher patent quadruple expansion.

Number.—2.

Diameters of cylinders.—11, 17, 24, and 32 inches.

Stroke.—15 inches.

Working pressure at cylinders.—350 to 400 pounds.

Revolutions.—540 to 600.

Piston speed.—1,500 feet.

Calculated power developed under 540 revolutions and 350 pounds at the engines.—About 4,000 indicated horse power.

Both engines exhaust into one condenser, which has a cooling surface of 2760 square feet. Between the steam cylinders of the engine a series of reheaters is installed, each one of which is capable of supplying the entire thermal equivalent of the work expended during the expansion, thus keeping the steam in a superheated condition throughout its working cycle. These are intended to aid in the drying of the steam and effectually preventing cylinder condensation. The air and feed pumps are just forward of the main engine, and are geared directly to the main shafts.

An important and interesting feature of the design of these engines is the arrangement of the columns and diagonal braces constituting the supporting framework of the steam and valve cylinders. This arrangement is clearly shown in the accompanying cuts and is designed to eliminate the danger of fracture, due to rapidly alternating compressive and tensile strains, to which the framing of extreme high speed and high powered engines of this class is commonly subject. It will be observed that the diagonal braces are secured together in pairs at their centers by means of a bolt and nuts, by the adjustment of which the supporting columns can be subjected to a compressive and the diagonal braces to a tensile strain which is intended to be in excess of any normal working strains which may come upon them. By this arrangement, it is obvious that the supporting columns will at all times be practically subjected to compressive strains only, varied in intensity as the working strains of the engine increase or relieve the initial stress due to the tension of the diagonal braces. These braces are in turn subjected to tensile strains only of varying intensity but constant to the extent of taking up and absorbing practically all the initial elasticity of the structure. A remarkably rigid construction is thus attained, assuring a practically perfect alignment of the engine at all times and greatly reducing vibration, since the initial or starting movement, without which there can be no vibration, is effectually prevented.

The feed water before returning to the boilers is heated in a pair of patent four-stage or compound feed water heaters of Mr. Mosher's design which are placed near the boiler room bulkhead. This style of heater is formed of a cylindrical shell with hemispherical ends and a series of transverse partitions dividing the internal space into four compartments. The compartment at one end is provided with a connection for the feed inlet, and that at the other end with a like connection for the outlet. Series of tubes pass through the several partitions and connect the two end compartments to each other, thereby forming a continuous conduit for the feed water, which thus traverses the several compartments in series. The spaces surrounding the tube in the compartments constitute independent chambers separated by the partitions and thus adapted to receive steam of different pressures for supplying the heat required. The first chamber is connected with the main exhaust pipe from the L. P. cylinder, and the feed is first heated from this source. It then passes on into the second chamber, the steam side of which is supplied from the L. P. steam chest or third receiver. In like manner, the third chamber is supplied with steam from the second intermediate steam chest or second receiver, and the fourth and last chamber from the first intermediate steam chest or first receiver.

In this manner the feed water is successively heated by a series of transfers of heat from the expanding or working part of the steam cycle, at a series of increasing temperatures, until it is finally delivered to the boiler at a temperature calculated to be about 350°. It is only recently that the full thermodynamic significance of this operation has been realized. Examination shows, however, that such a series of heat transfers aids directly in bettering the efficiency of the engine, by reason of the modification which is thus introduced into the steam cycle, such modifications having the effect of carrying the working cycle nearer to the ideal than it would otherwise be. The result is, therefore, a closer realization of the conditions for the cycle of the ideal engine, and hence a correspondingly higher efficiency.

In order to carry this operation to the fullest extent, and thus to realize substantially the full ideal efficiency, it would be necessary to take the feed water and raise it by an indefinitely large number of very small steps from the lower temperature to that of the boiler, drawing the steam for each step from the point in the expansion stage of the engine having a temperature only slightly greater than that of the water itself. In this way each increment of heat would be given up from the steam and received by the water at very nearly the same temperature, and by such a series of operations, the water would be raised to the temperature in the boiler. Such would very nearly fulfill the conditions for the heating of the water requisite to realize the highest efficiency so far as this part of the cycle is concerned; and it is readily seen that the four-stage heater as above described makes a close approximation to the practical fulfillment of these conditions.

As above stated, the power which is expected from the engines of the "Arrow" working under the conditions mentioned with 350 pounds of steam is about 4,000. The following relations will be of interest in this connection:

I. H. P. per square foot of grate surface.—33.

Heating surface per I. H. P. at 4,000 H. P.—1·39 square feet.

Weight in pounds per H. P. of engines, boilers including water, and all auxiliaries.—17·78.

In connection with the designed power, the points which will make for high economy, and hence for a large return per pound of boiler and per pound of coal, may be briefly summarized at this point.

The initial pressure is far beyond that which is found in current practice, even with torpedo boats and other high speed craft. The increase is from 100 to 150 pounds. This pressure corresponds to an elevation of the initial temperature of about 30°, and this would correspond to a gain of about 7 per cent. in the ideal efficiency as compared with that for say 250 pounds pressure, while if the pressure was increased 150 pounds, or to 400 pounds at the engine, corresponding to a rise of about 44°, it would in the ideal engine correspond to a gain of nearly 11 per cent. as compared with the usual practice of 250 pounds. We may next note the very considerable wire drawing from the boiler to the engine, which will tend to dry and superheat the steam and thus to aid in reducing the wastes due to internal condensation. The action of the reheaters will also serve in the same line to keep the steam dry or even superheated as it passes through the successive cylinders of the engine. The total number of expansions will be about 15·67, and they are carried out in a quadruple or four-stage expansion engine with the corresponding gains which may be justly expected when using steam of such high pressure as is here employed. To these various features we must add the action of the four-stage feed water heater as described above.

Then in the engine itself the cylinder clearances have been by careful design reduced to a very low value, a feature directly favorable to high efficiency of operation. Considering these various features which will bear on the question of the economy of the engine, it seems not too much to expect an exceedingly economical development of power. It would be, of course, unsafe to predict a water rate, but it would certainly not be surprising if it should fall to the vicinity of 10 pounds per indicated horse power per hour.

A further question of the greatest interest is in regard to the speed which may be expected. Here again predictions are unsafe for want of a precedent approaching the great increase of power per unit of displacement; but considering that the form of the boat has been especially designed for the attainment of the highest possible speeds, involving a large amount of model experiment directly carried out by Mr. Mosher, and assuming that 4,000 indicated horse power and probably more are developed on a mean displacement of 60 tons, or somewhat less for a speed run, a speed of something over 40 knots or 46·25 statute miles per hour may be confidently expected.

In the engine room there are besides the two sets of quadruple expansion engines for propelling the boat, each of which is fitted with a steam reversing engine, two engines for driving the blowers for supplying ventilation and forced draught, an electric light engine and dynamo, two circulating engines for pumping the injection water for the condenser, duplex bilge and fire pumps, an auxiliary air pump for supplying a vacuum when the air pumps attached to the main engines are not running, a distilling pump, and two evaporators and distillers of sufficient capacity to supply fresh water for the entire boat service. In addition to these are the steam steering engines and auxiliary feed pumps for the boiler room, two feed water heaters and condensers.

The hull has been constructed at the shipyard of Samuel Ayers & Son, of Nyack, N. Y., who also built the "Ellide" and a number of other fast boats from Mr. Mosher's designs. It is ready to receive its machinery, and will probably be launched before this reaches our readers. The boilers are nearing completion at the Crescent Shipyard, Elizabethport, N. J., and have already successfully withstood all their tests. The main engines and all auxiliaries have been constructed by the L. Wright Machine Works, Newark, N. J., Mr. W. R. Sands acting in the capacity of inspector for Mr. Flint.

Mr. Mosher is to the fast steam yacht what Mr. Herreshoff is to the sailing yacht. Both designers have turned out the fastest craft of their kind in the world, the "Ellide" and the "Columbia" standing at the head of the list for speed. Like Mr. Herreshoff, Mr. Mosher has the advantage of a lengthy experience in previous vessels of the particular type which he constructs, and with the data obtained in "Yankee Doodle," "Feiseen" and "Ellide" to go upon, it is reasonable to expect that in the "Arrow" he has produced a vessel that will be the first to reach the 40-knot mark.

RELATION OF SOILS TO TEMPERATURE.

KEEPING in mind the great influence directly and indirectly exerted by the temperature of the soil upon the growth of plants, the practical cultivator will endeavor to find means to modify the temperature according to the necessities of the plants, says The Gardeners' Magazine. In colder climates, naturally, efforts must be made to promote a rise in temperature, while in warmer regions it will often be necessary to proceed in the opposite direction. In what way, and to what extent, the temperature of the soil may be influenced is briefly described by Dr. Ewald Wollny as follows:

In the cultivation of plants which furnish products of high market value, such as vines, fruit trees, etc., and which require a rather high temperature, artificial changes in exposure or inclination (producing southwest, south, or southeast exposure, or inclining the plane of growth more directly toward the south) may be of considerable benefit, especially in cold climates. The method, however, will be productive of good results only when the soil contains sufficient moisture, because only in that case is the higher temperature beneficial and the increase in yield sufficient to justify the outlay required to make the change. This method need not be restricted to hilly lands, but can be applied to level soils. Roof-like elevations may be constructed, with broad surfaces facing toward the south, and rather narrow exposures toward the north. The former may be planted to crops that require considerable warmth (fruits, asparagus, etc.), and the latter may be reserved for grass or such other forage plants as require less heat. This method is not adapted to extensive field culture of crops furnishing products of comparatively low market value, both on account of the very unequal growth of the plants on the two opposite inclinations and because the benefit derived even under favorable circumstances would not justify the outlay.

On hilly land in hot climates a reduction of the temperature of the soil may be necessary on steep inclinations facing toward the south, southeast, or southwest, because under such conditions, not taking into account the fact that the moisture is generally insufficient for maximum crops, the temperature of the soil frequently exceeds the limits for the perfect development of plants. In such cases the construction of terraces offers special advantages, since by their means the temperature of the soil may be lowered and the moisture in the soil regulated in accordance with the needs of the plants. Another common method of altering the exposure of the soil consists in the construction of beds, running through the whole length of the field, and separated from each other by furrows. The effect of this arrangement is to bring about a more rapid removal of water from surfaces of high water capacity, but, leaving out of account the fact that this result may be accomplished by simple means (water furrows), the process in question has the disadvantage of producing unequal heating of two oppositely inclined surfaces, resulting in unequal growth of the plants on the two sides. For this reason, bed culture is not suited to fields that are to be planted with only one kind of crop. In such cases level cultivation, which secures a higher and more uniform temperature, is decidedly preferable. If, however, this method is followed, the bed should run north and south if the field permit, since the difference in temperature between the east and west slopes is far less marked than that of slopes facing north and south. In other words, the disadvantage of unequal heating is least with beds running north and south.

An excellent means of raising the temperature of the soil is the cultivation of plants in ridges or in hills. Soils so cultivated have a higher average temperature during the growing season than those cultivated level. The effect is of longer duration in ridge culture than in hill culture, because in the former the ridges are constructed before seed time, while in the latter the hills are made only in the more advanced stages of growth of the plants. For this reason ridge culture is especially suited to plants which require a considerable amount of heat (tomatoes, beets, etc.) in climates unfavorable, as regards temperature, to the growth of these plants. However, this is true only for regions in which the weather in spring is not too cold, for the plants growing on the top of the ridges are, on account of their exposed position, more easily injured by late frosts in spring than those planted on the level soil and hilled up later. As a general rule, both these methods are mainly adapted to such soils as have little capacity for collecting and retaining heat (clayey and calcareous soils), and which are also apt to collect excessive quantities of water. It is evident that the increase of temperature due to ridge or hill culture is of no advantage on soils of little water capacity and great permeability (sand) when precipitation is scanty. Under such conditions level culture is to be preferred. It should be remembered when ridge or hill culture is used that ridges running north and south are of higher and more uniform temperature than those running east and west.

Regulation of the store of water in the soil is another means of modifying the temperature. If the soil is wet, elevation of temperature is brought about by removal of the excess of moisture. The proper means to this end are direct removal of water, lowering water capacity, and increasing permeability of the soil, as already explained. That the desired result may be obtained by these means has been proved by various experiments. Another means of changing conditions of temperature in soils is intermixture with soils of opposite properties as regards heat. Admixture of sand with clay or earth rich in clay and limestone results, under normal conditions, in an average increase in the temperature of the soil, while the opposite process produces a lowering of the temperature of the soil. By thoroughly intermixing sand and humus a soil results which collects heat more rapidly and to a greater depth than is done by either separately. Increase of humus in mineral soils, as, for instance, by the liberal application of manures of organic origin, prevents extremes of temperature.

We thus see that not only the structure of the soil but also its temperature may be affected by mechanical means. Change from the separate grain structure to crumbly structure generally improves, though to a small degree, the heat conditions of a soil, principally by reducing evaporation. Rolling the soil is more effective, because it increases the conductivity of the soil for heat, and therefore, under normal conditions of weather, raises the temperature of the soil. Loosening the surface of the soil by harrowing, hoeing, etc., results, on the contrary, in a decrease in the temperature of the soil.

By covering the ground with dead matter (mulching) the temperature of the soil is increased or decreased according to the behavior of the covering toward heat. If, for example, a thin layer of black material (coal dust, black clay slate, etc.) is spread over the soil, the temperature of the soil rises to a considerable degree, and crops on soils so treated are accordingly benefited. Although this process, for evident reasons, is not applicable to cultivation on a large scale, still with delicate plants, especially in horticulture, it may be used to advantage. Spreading a layer of sand or

gravel over humus soils causes a rise in the temperature of the latter, and wholly or partially prevents the frequent night frosts which occur during spring in such soils.

Mulching with dead organic matter (stable manure, straw, etc.) may be used to lower the temperature of the soil during the warm portion of the year. By the same means the influence of the temperature of the air is diminished and the soil protected from all excessive changes in temperature. This is due to the fact that all the materials mentioned are poor conductors of heat. Allowing stable manure to remain spread out during the warm months on the surface of the soil for some time before it is worked into the soil may unfavorably affect the moisture of the soil. In the colder portion of the year, however, it may be beneficial on account of its influence in raising the temperature of the soil. Under such conditions, however, the covering of manure may exercise a harmful influence on fine-grained clay soils rich in humus by preventing the loosening effect of frosts, which is so important for such soils. Beneficial results may be obtained by thinly spreading a mulch in the autumn over fields occupied by perennial forage plants, thus protecting the plants against low, and especially changeable, winter temperatures. As, however, such a covering retards warming of the soil, the undecomposed remains of the mulch should be removed as soon as the temperature begins to rise in the spring.

Keeping in mind the fact that covering the soil in this manner retards warming in spring, this practice may also be utilized to retard the blossoming of fruit trees, thus diminishing or preventing damage from late frost. If the ground surrounding the trunk is covered in spring with a heavy layer of straw, the temperature is kept low, and in consequence the amount of water received through the roots is small, so that the development of the leaves, and especially the blossoms, is retarded for several weeks, or until the organs of reproduction are then in little danger of freezing.

[Continued from SUPPLEMENT, No. 1295, page 20761.]

THE AGE OF THE EARTH.*

By Prof. W. J. SOLLAS, D.Sc.

UNEXPECTED ABSENCE OF THERMAL METAMORPHOSIS IN ANCIENT ROCKS.

Two difficulties now remain for discussion, one based on theories of mountain chains, the other on the unaltered state of some ancient sediments. The latter may be taken first. Prof. Van Hise writes as follows regarding the pre-Cambrian rocks of the Lake Superior district: "The Penokee series furnishes an instructive lesson as to the depth to which rocks may be buried and yet remain but slightly affected by metamorphosis. The series itself is 14,000 feet thick. It was covered before being upturned with a great thickness of Keweenaw rock. This series at the Montreal River is estimated to be 50,000 feet thick. Adding to this the known thickness of the Penokee series, we have a thickness of 64,000 feet. . . . The Penokee rocks were then buried to a great depth, the exact amount depending upon their horizon and upon the stage in Keweenaw time when the tilting and erosion, which brought them to the surface, commenced.

"That the synclinal trough of Lake Superior began to form before the end of the Keweenaw period, and consequently that the Penokee rocks were not buried under the full succession, is more than probable. However, they must have been buried to a great depth, at least several miles, and thus subjected to high pressure and temperature, notwithstanding which they are comparatively unaltered." (Tenth Annual Report United States Geological Survey, 1888–89, p. 457.)

I select this example because it is one of the best instances of a difficulty that occurs more than once in considering the history of sedimentary rocks. On the supposition that the rate of increment of temperature with the descent is 1° F. for every 84 feet, or 1° C. for every 150 feet, and that it was no greater during these early Penokee times, then at a depth of 50,000 feet the Penokee rocks would attain a temperature of nearly 333° C.; and since water begins to exert powerful chemical action at 180° C. they should, on the theory of a solid cooling globe, have suffered a metamorphosis sufficient to obscure their resemblance to sedimentary rocks. Either then the accepted rate of downward increase of temperature is erroneous, or the Penokee rocks were never depressed, in the place where they are exposed to observation, to a depth of 50,000 feet. Let us consider each alternative, and in the first place let us apply the rate of temperature increment determined by Prof. Agassiz in this very Lake Superior district; it is 1° C. for every 402 feet, and 25,000,000 of years ago, or about the time when we may suppose the Penokee rocks were being formed, it would be 1° C. for every 305·5 feet, with a resulting temperature at a depth of 50,000 feet of 163° C. only. Thus, the admission of a very low rate of temperature increment would meet the difficulty; but on the other hand it would involve a period of several hundreds of millions of years for the age of the "consistentior status," and thus greatly exceed Prof. Joly's maximum estimate of the age of the oceans.

We may, therefore, turn to the second alternative. As regards this, it is by no means certain that the exposed portion of the Penokee series ever was depressed 50,000 feet; the beds lie in a synclinal, the base of which, indeed, may have sunk to this extent, and entered a region of metamorphosis; but the only part of the system that lies exposed to view is the upturned margin of the synclinal, and as to this it would seem impossible to make any positive assertion as to the depth to which it may or may not have been depressed. To keep an open mind on the question seems our only course for the present, but difficulties like this offer a promising field for investigation.

THE FORMATION OF MOUNTAIN RANGES.

It is frequently alleged that mountain chains cannot be explained on the hypothesis of a solid earth cooling under the conditions and for the period we have supposed. This is a question well worthy of consideration, and we may first endeavor to picture to ourselves the conditions under which mountain chains arise. The floor of the ocean lies at an average depth of 2,000 fathoms below the land, and is maintained at a constant temperature, closely approaching 0° C., by the passage over it of cold water creeping from the polar regions. The average temperature of the surface of the land is above zero, but we can afford to disregard the difference in temperature between it and the ocean floor, and may take them both at zero. Consider next the increase of temperature with descent, which occurs beneath the continents; at a depth of 13,000 feet, or at same depth as the ocean floor, a temperature of 87° C. will be reached on the supposition that the rate of increase is 1° C. for 150 feet, while with the usually accepted rate of 1° C. for 108 feet it would be 120° C. But at this depth the ocean floor, which is on the same spherical surface, is at 0° C. Thus surfaces of equal temperature within the earth's crust will not be spherical, but will rise or fall beneath an imaginary spherical or spheroidal surface according as they occur beneath the continents or the oceans.

No doubt at some depth within the earth the departure of isothermal surfaces from a spheroidal form will disappear; but considering the great breadth both of continents and oceans, this depth must be considerable, possibly even forty or fifty miles. Thus, the sub-continental excess of temperature may make itself felt in regions where the rocks still retain a high temperature, and are probably not far removed from the critical fusion point. The effect will be to render the continents mobile as regards the ocean floor; or, vice versa, the ocean floor will be stable compared with the continental masses. Next it may be observed that the continents pass into the bed of the ocean by a somewhat rapid flexure, and that it is over this area of flexure that the sediments denuded from the land are deposited. Under its load of sediment the sea floor sinks down, subsiding slowly, at about the same rate as the thickness of sediment increases; and, whether as a consequence or a cause, or both, the flexure marking the boundary of land and sea becomes more pronounced.

A compensating movement occurs within the earth's crust, and solid material may flow from under the subsiding area in the direction of least resistance, possibly toward the land. At length, when some thirty or forty thousand feet of sediment have accumulated in a basin-like form, or, according to our reckoning, after the lapse of three or four millions of years, the downward movement ceases, and the mass of sediment is subjected to powerful lateral compression, which, bringing its borders into closer proximity by some ten or thirty miles, causes it to rise in great folds high into the air as a mountain chain.

It is this last phase in the history of mountain making which has given geologists more cause for painful thought than probably any other branch of their subject, not excluding even the age of the earth. It was at first imagined that during the flow of time the interior of the earth lost so much heat, and suffered so much contraction in consequence, that the exterior, in adapting itself to the shrunken body, was compelled to fit it like a wrinkled garment. This theory, indeed, enjoyed a happy existence till it fell into the hands of mathematicians, when it fared very badly, and now lies in a pitiable condition neglected of its friends.*

For it seemed proved to demonstration that the contraction consequent on cooling was wholly, even ridiculously, inadequate to explain the wrinkling. But when we summon up courage to inquire into the data on which the mathematical arguments are based, we find that they include several assumptions, the truth of which is by no means self-evident. Thus it has been assumed that the rate at which the fusion point rises with increased pressure is constant, and follows the same law as is deduced from experiments made under such pressures as we can command in our laboratories down to the very center of the earth, where the pressures are of an altogether different order of magnitude; so with a still more important coefficient, that of expansion, our knowledge of this quantity is founded on the behavior of rocks heated under ordinary atmospheric pressure, and it is assumed that the same coefficient as is thus obtained may be safely applied to material which is kept solid, possibly near the critical point, under the tremendous pressure of the depths of the crust.

To this last assumption we owe the terrible bogies that have been conjured out of "the level of no strain." The depth of this as calculated by the Rev. O. Fisher is so trifling that it would be passed through by all very deep mines. Mr. C. Davison, however, has shown that it will lie considerably deeper, if the known increase of the coefficient of expansion with rise of temperature be taken into account. It is possible, it is even likely, that the coefficient of expansion becomes vastly greater when regions are entered where the rocks are compelled into the solid state by pressure. So little do we actually know of the behavior of rock under these conditions that the geologist would seem to be left very much to his own devices; but it would seem there is one temptation he must resist, he may not take refuge in the hypothesis of a liquid interior.

We shall boldly assume that the contraction at some unknown depth in the interior of the earth is sufficient to afford the explanation we seek. The course of events may then proceed as follows: The contraction of the interior of the earth, consequent on its loss of heat, causes the crust to fall upon it in folds, which rise over the continents and sink under the oceans, and the flexure of the area of sedimentation is partly a consequence of this folding, partly of overloading. By the time a depression of some 30,000 or 40,000 feet has occurred along the ocean border the relation between continents and oceans has become unstable, and readjustment takes place, probably by a giving way of the continents, and chiefly along the zone of greatest weakness, i. e., the area of sedimentation, which thus becomes the zone of mountain building. It may be observed that at great depths readjustment will be produced by a slow flowing of solid rock, and it is only comparatively near the surface, five or ten miles at the most below, that failure of support can lead to sudden fracture and collapse; hence the comparatively superficial origin of earthquakes.

Given a sufficiently large coefficient of expansion, and there is much to suggest its existence, and all the phenomena of mountain ranges become explicable; they begin to present an appearance that invites mathematical treatment; they inspire us with the hope that from a knowledge of the height and dimensions of a continent and its relations to the bordering ocean we may be able to predict when and where a mountain chain should arise, and the theory which explains them promises to guide us to an interpretation of those world-wide unconformities which Suess can only account for by a transgression of the sea. Finally it relieves us of the difficulty presented by mountain formation in regard to the estimated duration of geological time.

INFLUENCE OF VARIATIONS IN THE ECCENTRICITY OF THE EARTH'S ORBIT.

This may, perhaps, be the place to notice a highly interesting speculation which we owe to Prof. Blytt, who has attempted to establish a connection between periods of readjustment of the earth's crust and variations in the eccentricity of the earth's orbit. Without entering into any discussion of Prof. Blytt's methods, we may offer a comparison of his results with those that follow from our rough estimate of one foot of sediment accumulated in a century.

TABLE SHOWING THE TIME THAT HAS ELAPSED SINCE THE BEGINNING OF THE SYSTEMS IN THE FIRST COLUMN, AS RECKONED FROM THICKNESS OF SEDIMENT IN THE SECOND COLUMN, AND BY PROF. BLYTT IN THE THIRD.

	Years.	Years.
Eocene	4,200,000	3,250,000
Oligocene	3,000,000	1,810,000
Miocene	1,800,000	1,160,000
Pliocene	900,000	700,000
Pleistocene	400,000	350,000

It is now time to return to the task, too long postponed, of discussing the data from which we have been led to conclude that a probable rate at which sediments have accumulated in places where they attain their maximum thickness is one foot per century.

RATE OF DEPOSITION OF SEDIMENT.

We owe to Sir Archibald Geikie a most instructive method of estimating the existing rate at which our continents and islands are being washed into the sea by the action of rain and rivers; by this we find that the present land surface is being reduced in height to the extent on an average of 1/2400 foot yearly (according to Prof. Penck, 1/3600 foot). If the material removed from the land were uniformly distributed over an area equal to that from which it had been derived, it would form a layer of rock 1/2400 foot thick yearly, i. e., the rates of denudation and deposition would be identical. But the two areas, that of denudation and that of deposition, are seldom or never equal, the latter as a rule being much the smaller. Thus the area of that part of North America which drains into the Gulf of Mexico measures 1,800,000 square miles; the area over which its sediments are deposited is, so far as I can gather from Prof. Agassiz's statements, less than 180,000 square miles; while Mr. McGee estimates it at only 100,000 square miles. Using the largest number, the area of deposition is found to measure one-tenth the area of denudation; the average rate of deposition will therefore be ten times as great as the rate of denudation, or $\frac{1}{240}$ foot may be supposed to be uniformly distributed over the area of sedimentation in the course of a year. But the thickness by which we have measured the strata of our geological systems is not an average, but a maximum thickness; we have, therefore, to obtain an estimate of the maximum rate of deposition. If we assume the deposited sediments to be arranged somewhat after the fashion of a wedge with the thin end seaward, then twice the average would give us the maximum rate of deposition; this would be one foot in 120 years. But the sheets of deposited sediment are not merely thicker toward the land, thinner toward the sea; they also increase in thickness toward the rivers in which they have their source, so that a very obtuse-angled cone, or, better, the down-turned bowl of a spoon, would more nearly represent their form.

This form tends to disappear under the action of waves and currents, but a limit is set to this disturbing influence by the subsidence which marks the region, opposite the mouth of a large river. By this the strata are gradually let downward, so that they come to assume the form of the bowl of a spoon turned upward. Thus a further correction is necessary if we are to arrive at a fair estimate of the maximum rate of deposition. Considering the very rapid rate at which our ancient systems diminish in thickness when traced in all directions from the localities where they attain their maximum, it would appear that this correction must be a large one. If we reduce our already corrected estimate by one-fifth, we arrive at a rate of one foot of sediment deposited in a century.

No doubt this value is often exceeded; thus in the case of the Mississippi River, the bar of the Southwest Pass advanced between the years 1838 and 1874 a distance of over 2 miles, covering an area of 2·2 miles in width with a deposit of sediment 80 feet in thickness; outside the bar, where the sea is 250 feet in depth, sediment accumulates, according to Messrs. Humphreys and Abbot, at a rate of 2 feet yearly. It is quite possible, indeed it is very likely, that some of our ancient strata have been formed with corresponding rapidity. No gravel or coarse sand is deposited over the Mississippi delta; such material is not carried further seaward than New Orleans. Thus the vast sheets of conglomerate and sandstone which contribute so largely to some of our ancient systems, such as the Cambrian, Old Red Sandstone, Millstone Grit, and Coal measures, must have accumulated under very different conditions, conditions for which it is not easy to find a parallel; but in any case these deposits afford evidence of very rapid accumulation.

These considerations will not tempt us, however, to modify our estimate of one foot in a century; for though in some cases this rate may have been exceeded, in others it may not have been nearly attained.

Closely connected with the rate of deposition is that of the changing level of land and sea; in some cases, as in the Wealden delta, subsidence and deposition appear

* Opening address by the President of the Section of Geology, British Association.

* With some exceptions, notably Mr. C. Davison, a consistent supporter of the theory of contraction.

to have proceeded with equal steps, so that we might regard them as transposable terms. It would, therefore, prove of great assistance if we could determine the average rate at which movements of the ground are proceeding; it might naturally be expected that the accurate records kept by tidal gages in various parts of the world would afford us some information on this subject; and no doubt they would, were it not for the singular misbehavior of the sea, which does not maintain a constant level, its fluctuations being due, according to Prof. Darwin, to the irregular melting of ice in the polar regions. Of more immediate application are the results of Herr L. Holmström's observations in Scandinavia, which prove an average rise of the peninsula at the rate of 3 feet in a century to be still in progress; and Mr. G. K. Gilbert's measurements in the great lake district of North America, which indicate a tilting of the continent at the rate of 3 inches per hundred miles per century. But while measurements like these may furnish us with some notion of the sort of speed of these changes, they are not sufficient even to suggest an average; for this we must be content to wait till sufficient tidal observations have accumulated, and the disturbing effect of the inconstancy of the sea level is eliminated.

It may be objected that in framing our estimate we have taken into account mechanical sediments only, and ignored others of equal importance, such as limestone and coal. With regard to limestone, its thickness in regions where systems attain their maximum may be taken as negligible; nor is the formation of limestone necessarily a slow process. The successful experiments of Dr. Allan, cited by Darwin, prove that reef-building corals may grow at the astonishing rate of six seet in height per annum.

In respect of coal there is much to suggest that its growth was rapid. The carboniferous period well deserves its name, for never before, never since, have carbonaceous deposits accumulated to such a remarkable thickness or over such wide areas of the earth's surface. The explanation is doubtless partly to be found in favorable climatal conditions, but also, I think, in the youthful energy of a new and overmastering type of vegetation, which then for the first time acquired the dominion of the land. If we turn to our modern peat bogs, the only carbonaceous growths available for comparison, we find from data given by Sir A. Geikie that a fairly average rate of increase is six feet in a century, which might perhaps correspond to one foot of coal in the same period.

The rate of deposition has been taken as uniform through the whole period of time recorded by stratified rocks; but lest it should be supposed that this involves a tacit admission of uniformity, I hasten to explain that in this matter we have no choice; we may feel convinced that the rate has varied from time to time, but in what direction, or to what extent, it is impossible to conjecture. That the sun was once much hotter is probable, but equally so that at an earlier period it was much colder; and even if in its youth all the activities of our planet were enhanced, this fact might not affect the maximum thickness of deposits. An increase in the radiation of the sun, while it would stimulate all the powers of subaerial denudation, would also produce stronger winds and marine currents; stronger currents would also result from the greater magnitude and frequency of the tides, and thus while larger quantities of sediment might be delivered into the sea they would be distributed over wider areas, and the difference between the maximum and average thickness of deposits would consequently be diminished. Indications of such a wider distribution may perhaps be recognized in the Palæozoic systems. Thus we are compelled to treat our rate of deposition as uniform, notwithstanding the serious error this may involve.

If one foot in a century be a quantity so small as to disappoint the imagination of its accustomed exercise, let us turn to the Cambrian succession of Scandinavia, where all the zones recognized in the British series are represented by a column of sediment 290 feet in thickness. If 1,600,000 years be a correct estimate of the duration of Cambrian time, then each foot of the Scandinavian strata must have occupied 5,513 years in its formation. Are these figures sufficiently inconceivable?

In the succeeding system, that of the Ordovician, the maximum thickness is 17,000 feet. Its deposits are distributed over a wider area than the Cambrian, but they also occupied longer time in their formation; hence the area from which they were derived need not necessarily have been larger than that of the preceding period.

Great changes in the geography of our area ushered in the Silurian system; its maximum thickness is found over the Lake district, and amounts to 15,000 feet; but in the little island of Gothland, where all the subdivisions of the system, from the Landovery to the Upper Ludlow, occur in complete sequence, the thickness is only 208 feet. In Gothland, therefore, according to our computation, the rate of accumulation was one foot in 7,211 years.

With this example we must conclude, merely adding that the same story is told by other systems and other countries, and that, so far as my investigations have extended, I can find no evidence which would suggest an extension of the estimate I have proposed. It is but an estimate, and those who have made acquaintance with "estimates" in the practical affairs of life know how far this kind of computation may guide us to or from the truth.

This address is already unduly long, and yet not long enough for the magnitude of the subject of which it treats. As we glance backward over the past we see catastrophism yield to uniformitarianism, and this to evolution, but each as it disappears leaves behind some precious residue of truth. For the future of our science our ambition is that which inspired the closing words of your last president's address, that it may become more experimental and exact. Our present watchword is evolution. May our next be measurement and experiment, experiment and measurement.

Charge for Dry Battery.—

Calcium chloride, in crystals	30	parts.
Calcium chloride, granulated	30	"
Zinc sulphate, in crystals	25	"
Ammonium sulphate	15	"

READY OCTOBER 20th.

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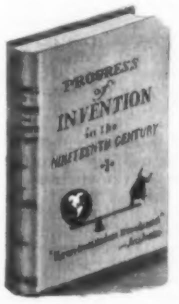

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